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

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Abstract

The present investigation entitled, “Effect of Integrated Nutrient Management on Yield and quality Parameters of French Bean (*Phaseolus vulgaris* L.)” conducted at University Research Farm, Departmental of Horticulture, School of Agricultural Sciences, G.H. Rasoni University, Saikheda, Pandhurna, Madhya Pradesh during Rabi 2024. Data pertaining to various criteria used for treatment evaluation were analyzed statistically to test their significance and analysis of variance for these data has been given in appendices at the end. The research trail was carried on French bean crop. The application of organic and inorganic fertilizers like T₁-Control (No fertilizer, no organic manure, no biofertilizer), T₂-100% Recommended Dose of Fertilizer (RDF) (NPK), T₃-75% RDF + 25% N through Farmyard Manure (FYM), T₄-75% RDF + 25% N through Vermicompost, T₅-75% RDF + Rhizobium inoculation, T₆-75% RDF + Phosphate Solubilizing Bacteria (PSB), T₇-75% RDF + 25% N through FYM + Rhizobium, T₈-75% RDF + 25% N through Vermicompost + Rhizobium, T₉-75% RDF + 25% N through Vermicompost + Rhizobium + PSB and T₁₀-50% RDF + 25% N through FYM + 25% N through Vermicompost + Rhizobium + PSB was used for the experiment for observed the growth parameters. The research trail was carried on French bean for observed the growth, yield and quality i.e. Observations were recorded on various yield parameters, namely Yield and Yield Attributing Parameters like Number of Pods per Plant, Pod Length (cm), Pod Diameter (cm), Average Pod Weight (g), Number of Seeds per Pod, Green Pod Yield per Plant (g), Green Pod Yield per Plot (kg), Green Pod Yield per Hectare (t ha⁻¹), Quality Parameters like Dry Matter Content (%). The result revealed that maximum Number of Pods per Plant (45.88), Pod Length (16.08 cm), Pod Diameter (1.38 cm), Average Pod Weight (8.80 g), Number of Seeds per Pod (8.10), Green Pod Yield per Plant (412.70 g), Green Pod Yield per Plot (14.86 kg), Green Pod Yield per Hectare (45.86 t ha⁻¹), Quality Parameters like Dry Matter Content (16.10%) was observed under the treatments T₁₀ while minimum value of all given parameters was observed under the control.

Keywords: French bean, integrated nutrient management, vermicompost, rhizobium, PSB

Introduction

French bean (*Phaseolus vulgaris* L.) is an important vegetable legume because of its relatively short crop duration, high consumer acceptance and potential for profitable production. It is cultivated in diverse agro-ecological conditions and is primarily harvested for its immature green pods. The crop has considerable nutritional significance because its edible pods contain proteins, carbohydrates, vitamins and minerals. As a legume, French bean also interacts with nitrogen-fixing bacteria and can contribute to biological nitrogen acquisition through symbiotic associations. However, productivity is strongly influenced by soil fertility, nutrient availability and the efficiency with which applied nutrients are utilized by the crop.

Sustainable nutrient management is therefore essential for maintaining high productivity while preserving soil quality. Integrated Nutrient Management provides an effective strategy by combining mineral fertilizers with organic manures and microbial inoculants to achieve a more balanced nutrient supply. FYM and vermicompost release nutrients gradually and contribute organic matter, improved soil structure and greater microbial activity, whereas *Rhizobium* and PSB can enhance nitrogen fixation and phosphorus mobilization. The complementary action of these nutrient sources can improve nutrient-use efficiency and support continuous crop growth from establishment through pod development.

Parween (2019) ^[6] reported beneficial effects of integrated nutrient management involving RDF, FYM, vermicompost and Rhizobium + PSB on French bean, while Changkiri *et al.*, (2024) ^[3] demonstrated that partial substitution of inorganic nitrogen with vermicompost improved plant growth, pod characteristics, yield, quality and benefit-cost ratio. Kumar *et al.*, (2020) ^[5] ^[5] further demonstrated that integrated nutrient application involving inorganic fertilizer, FYM and plant-growth-promoting microorganisms improved productivity and profitability of French bean.

The effectiveness of INM, however, depends on the proportion and combination of nutrient sources, soil conditions and crop environment. Therefore, evaluating suitable combinations of inorganic fertilizers, FYM, vermicompost and biofertilizers is important for developing an efficient nutrient-management strategy for French bean. Such an approach can simultaneously address crop nutrient requirements, improve productivity and profitability, and contribute to the maintenance of soil fertility.

Materials and Methods

The present investigation entitled, “Effect of Integrated Nutrient Management on Yield and quality Parameters of French Bean (*Phaseolus vulgaris* L.)” conducted at University Research Farm, Departmental of Horticulture, School of Agricultural Sciences, G.H. Rasoni University, Saikheda, Pandhurna, Madhya Pradesh during Rabi 2024. Data pertaining to various criteria used for treatment evaluation were analyzed statistically to test their significance and analysis of variance for these data has been given in appendices at the end. The research trail was carried on French bean crop. The application of organic and inorganic fertilizers like T₁-Control (No fertilizer, no organic manure, no biofertilizer), T₂-100% Recommended Dose of Fertilizer (RDF) (NPK), T₃-75% RDF + 25% N through Farmyard Manure (FYM), T₄-75% RDF + 25% N through Vermicompost, T₅-75% RDF + Rhizobium inoculation, T₆-75% RDF + Phosphate Solubilizing Bacteria (PSB), T₇-75% RDF + 25% N through FYM + Rhizobium, T₈-75% RDF + 25% N through Vermicompost + Rhizobium, T₉-75% RDF + 25% N through Vermicompost + Rhizobium + PSB and T₁₀-50% RDF + 25% N through FYM + 25% N through Vermicompost + Rhizobium + PSB was used for the experiment for observed the growth parameters. The research trail was carried on French bean for observed the growth, yield and quality i.e. Observations were recorded on various yield parameters, namely Yield and Yield Attributing Parameters Number of Pods per Plant, Pod Length (cm), Pod Diameter (cm), Average Pod Weight (g), Number of Seeds per Pod, Green Pod Yield per Plant (g), Green Pod Yield per Plot (kg), Green Pod Yield per Hectare (t ha⁻¹), Quality Parameters like Dry Matter Content (%).

Dry Matter Content (%) = (Dry Weight/Fresh Weight) × 100

Results and Discussion

Number of pods per plant

The maximum number of pods per plant (45.88) was recorded under T₁₀ (50% RDF + 25% N through FYM + 25% N through Vermicompost + Rhizobium + PSB), which was significantly superior to all other treatments. This treatment was followed by T₉ (41.68 pods), T₈ (37.18 pods)

and T₇ (33.78 pods per plant). The minimum number of pods per plant (17.38) was recorded in the control treatment (T₁).

The higher pod production under T₁₀ may be attributed to the balanced and sustained availability of nutrients, particularly nitrogen and phosphorus, which promotes vigorous vegetative growth, flowering, flower retention and pod formation. Vermicompost and FYM also improve soil fertility and microbial activity, while Rhizobium and PSB enhance nitrogen fixation and phosphorus availability, respectively. Similar improvement in pod number of French bean under integrated nutrient management was reported by Kumar *et al.* (2020) ^[5] and Changkiri *et al.* (2024) ^[3]. The superiority of T₁₀ may also be related to better nutrient-use efficiency and enhanced photosynthetic activity, resulting in greater assimilate production and its translocation towards reproductive organs. The combined use of organic and inorganic nutrient sources can maintain nutrient availability throughout crop growth, thereby supporting pod initiation and development. Poonam *et al.* (2023) ^[7] also reported significantly higher yield attributes of French bean under integrated nutrient management involving RDF, FYM and vermicompost. (journalijpss.com)

Pod length (cm)

The maximum pod length (16.08 cm) was recorded under T₁₀ (50% RDF + 25% N through FYM + 25% N through Vermicompost + Rhizobium + PSB), which was significantly superior to all other treatments. This was followed by T₉ (15.23 cm), T₈ (14.48 cm) and T₇ (13.78 cm). The minimum pod length (9.01 cm) was observed under Control. The superior pod length under T₁₀ may be attributed to the balanced and sustained availability of nutrients from inorganic and organic sources, which enhanced vegetative growth, photosynthetic activity and assimilate translocation towards developing pods. FYM and vermicompost improve soil fertility and nutrient availability, while Rhizobium and PSB contribute to improved biological nitrogen fixation and phosphorus availability, thereby promoting pod development. Singh *et al.* (2011) ^[9] reported that integration of vermicompost with fertilizers improved pod length and pod yield of French bean. Similarly, Barcchiya and Kushwah (2017) ^[2] recorded maximum pod length under an integrated treatment comprising vermicompost, Rhizobium, PSB and inorganic nutrients. Changkiri *et al.* (2024) ^[3] also reported superior pod length under integrated nutrient management, with 75% inorganic NPK + 25% N through vermicompost producing a pod length of 13.96 cm.

Pod diameter (cm)

The maximum pod diameter (1.38 cm) was recorded under T₁₀ (50% RDF + 25% N through FYM + 25% N through Vermicompost + Rhizobium + PSB), which was significantly superior to all other treatments. This treatment was followed by T₉ (1.30 cm), T₈ (1.22 cm) and T₇ (1.15 cm). The minimum pod diameter (0.82 cm) was observed under the control treatment (T₁). The greater pod diameter under T₁₀ may be attributed to the balanced and sustained supply of nutrients, which enhanced photosynthetic activity, assimilate production and translocation towards developing pods. FYM and vermicompost improve soil fertility and nutrient availability, while Rhizobium and PSB enhance nitrogen fixation and phosphorus availability, favouring pod

enlargement. Rajput *et al.* (2011) ^[8] reported that integrated nutrient management significantly improved pod length, pods per plant and other yield attributes of French bean. Similarly, Azad and Tomar (2022) ^[1] recorded the highest pod width (1.29 cm) with 75% NPK + 25% N through vermicompost, supporting the beneficial effect of integrated organic and inorganic nutrition on pod development.

Average pod weight (g)

The highest average pod weight (8.80 g) was recorded under T₁₀ (50% RDF + 25% N through FYM + 25% N through Vermicompost + Rhizobium + PSB), which was significantly superior to all other treatments. This was followed by T₉ (8.20 g), T₈ (7.60 g) and T₇ (7.10 g). The lowest average pod weight (4.80 g) was observed under the control treatment (T₁). The higher pod weight under T₁₀ may be attributed to the balanced supply of nutrients and improved nutrient-use efficiency resulting from the combined application of inorganic fertilizer, FYM, vermicompost and biofertilizers. Adequate nitrogen and phosphorus availability enhances photosynthetic activity and assimilate translocation towards developing pods, thereby improving pod filling and fresh biomass. Barcchiya and Kushwah (2017) ^[2] reported that integrated application of vermicompost, Rhizobium, PSB and inorganic nutrients significantly improved yield attributes of French bean, including pod development. Similarly, Parween *et al.*, (2019) ^[6] observed improved yield attributes under integrated nutrient management involving RDF, FYM/vermicompost and Rhizobium + PSB.

Number of seeds per pod

The maximum number of seeds per pod (8.10) was recorded under T₁₀ (50% RDF + 25% N through FYM + 25% N through Vermicompost + Rhizobium + PSB), which was significantly superior to all other treatments. This treatment was followed by T₉ (7.50 seeds), T₈ (7.00 seeds) and T₇ (6.60 seeds per pod). The minimum number of seeds per pod (4.50) was observed under the control treatment (T₁). The higher pod weight under T₁₀ may be attributed to the balanced supply of nutrients and improved nutrient-use efficiency resulting from the combined application of inorganic fertilizer, FYM, vermicompost and biofertilizers. Adequate nitrogen and phosphorus availability enhances photosynthetic activity and assimilate translocation towards developing pods, thereby improving pod filling and fresh biomass. Barcchiya and Kushwah (2017) ^[2] reported that integrated application of vermicompost, Rhizobium, PSB and inorganic nutrients significantly improved yield attributes of French bean, including pod development. Similarly, Parween *et al.*, (2019) ^[6] observed improved yield attributes under integrated nutrient management involving RDF, FYM/vermicompost and Rhizobium + PSB.

Green pod yield per plant (g)

The highest green pod yield per plant (412.70 g) was recorded under T₁₀ (50% RDF + 25% N through FYM + 25% N through Vermicompost + Rhizobium + PSB), which was significantly superior to all other treatments. This treatment was followed by T₉ (350.10 g), T₈ (290.30 g) and T₇ (247.10 g). The lowest green pod yield per plant (88.30 g) was observed under the control treatment (T₁). The higher yield under T₁₀ may be attributed to the complementary and sustained supply of nutrients from inorganic fertilizer, FYM and vermicompost, coupled with improved nutrient availability through Rhizobium and PSB. This combination promotes vigorous plant growth, better flowering, pod formation and assimilate translocation, ultimately increasing green pod yield. Barcchiya and Kushwah (2017) ^[2] reported significantly higher pod number and yield attributes with integrated application of vermicompost, Rhizobium, PSB and inorganic nutrients in French bean. Similarly, Parween (2019) ^[6] reported improved pod yield under integrated nutrient management involving RDF, FYM/vermicompost and Rhizobium + PSB. Azad and Tomar (2022) ^[1] also found that integrated application of inorganic NPK with vermicompost significantly increased green pod weight per plant and total green pod yield compared with the unfertilized control.

Green Pod Yield per Plot (kg)

The maximum green pod yield per plot (14.86 kg) was recorded under T₁₀ (50% RDF + 25% N through FYM + 25% N through Vermicompost + Rhizobium + PSB), which was significantly superior to all other treatments. This treatment was followed by T₉ (12.60 kg), T₈ (10.45 kg) and T₇ (8.90 kg). The lowest green pod yield per plot (3.18 kg) was observed under the control treatment (T₁).

Green pod yield per hectare (t ha⁻¹)

The maximum green pod yield per hectare (45.86 t ha⁻¹) was recorded under T₁₀ (50% RDF + 25% N through FYM + 25% N through Vermicompost + Rhizobium + PSB), which was significantly superior to all other treatments. This treatment was followed by T₉ (38.89 t ha⁻¹), T₈ (32.25 t ha⁻¹) and T₇ (27.47 t ha⁻¹). The minimum green pod yield per hectare (9.82 t ha⁻¹) was observed under the control treatment (T₁).

Dry Matter Content (%)

The highest dry matter content (16.10%) was recorded under T₁₀ (50% RDF + 25% N through FYM + 25% N through Vermicompost + Rhizobium + PSB), which was significantly superior to all other treatments. This treatment was followed by T₉ (15.20%), T₈ (14.40%) and T₇ (13.70%). The lowest dry matter content (10.80%) was observed in the control treatment (T₁), where no fertilizer, organic manure or biofertilizer was applied.

Table 1: Effect of integrated nutrient management on Yield and quality Parameters of french bean crop

Treatment	No. of Pods per Plant	Pod Length (cm)	Pod Diameter (cm)	Average Pod Weight (g)	No. of Seeds per Pod	Green Pod Yield per Plant (g)	Green Pod Yield per Plot (kg)	Green pod yield per hectare (t ha ⁻¹)	Dry Matter Content (%)
T ₁	17.38	9.01	0.82	4.8	4.5	88.3	3.18	9.82	10.8
T ₂	23.58	11.28	0.95	5.6	5.2	137.8	4.96	15.32	11.6
T ₃	26.78	11.94	1.01	6.1	5.7	169.6	6.11	18.86	12.2
T ₄	29.48	12.65	1.08	6.5	6.1	198.3	7.14	22.04	12.9
T ₅	28.18	12.38	1.05	6.3	5.9	184.0	6.62	20.43	12.6
T ₆	27.68	12.12	1.03	6.2	5.8	177.9	6.4	19.75	12.4
T ₇	33.78	13.78	1.15	7.1	6.6	247.1	8.9	27.47	13.7
T ₈	37.18	14.48	1.22	7.6	7	290.3	10.45	32.25	14.4
T ₉	41.68	15.23	1.3	8.2	7.5	350.1	12.6	38.89	15.2
T ₁₀	45.88	16.08	1.38	8.8	8.1	412.7	14.86	45.86	16.1
S.Em±	0.247	0.060	0.005	0.035	0.031	2.880	0.104	0.320	0.048
CD at 5%	0.735	0.177	0.014	0.104	0.093	8.558	0.308	0.951	0.142

Conclusion

The present investigation clearly demonstrated that Integrated Nutrient Management significantly improved the yield and quality characteristics of French bean (*Phaseolus vulgaris* L.). Among the treatments, T₁₀ (50% RDF + 25% N through FYM + 25% N through vermicompost + Rhizobium + PSB) proved to be the most effective treatment and recorded the maximum number of pods per plant (45.88), pod length (16.08 cm), pod diameter (1.38 cm), average pod weight (8.80 g), number of seeds per pod (8.10), green pod yield per plant (412.70 g), green pod yield per plot (14.86 kg) and green pod yield per hectare (45.86 t ha⁻¹).

The same treatment also recorded the highest dry matter content (16.10%), indicating that integrated nutrient management improved not only productivity but also the quality of green pods. In contrast, the control (T₁) consistently recorded the lowest values, with 17.38 pods per plant, 9.01 cm pod length, 0.82 cm pod diameter, 4.80 g average pod weight, 4.50 seeds per pod, 9.82 t ha⁻¹ green pod yield, 10.80% dry matter.

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