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**Ansaba V**
Department of Vegetable Science, CA, OUAT, Bhubaneswar, Odisha, India

**M Pathak**
Department of Vegetable Science, CA, OUAT, Bhubaneswar, Odisha, India

**SK Dash**
Directorate of Research, AICRP on Vegetable Crops, OUAT, Bhubaneswar, Odisha, India

**Corresponding Author:**
**Ansaba V**
Department of Vegetable Science, CA, OUAT, Bhubaneswar, Odisha, India

# Soil properties and yield as influenced by bulky manures and chemical fertilizers in French bean

**Ansaba V, M Pathak and SK Dash**

**Abstract**
The field experiment was carried out during the *Rabi* season of 2018-19 at Odisha University of Agriculture and Technology (OUAT), Bhubaneswar, Odisha, India. The experiment was laid out in Randomized Block Design (RBD) with eight treatments replicated thrice. The eight treatment schedules were $T_1$ (100% NPK through inorganic source), $T_2$ (75% NPK through inorganic source + 25% N through FYM), $T_3$ (75% NPK through inorganic source + 25% N through vermicompost), $T_4$ (50% NPK through inorganic source + 50% N through FYM), $T_5$ (50% NPK through inorganic source + 50% N through vermicompost), $T_6$ (25% NPK through inorganic source + 75% N through FYM), $T_7$ (25% NPK through inorganic source + 75% N through vermicompost) and $T_8$ (control, no fertilizer). All the recommended package of practices except nutrient management was given uniformly to all the treatments to raise a good crop. In this investigation, the results revealed that application of 75% NPK through inorganic source along with 25% N through vermicompost ($T_3$) recorded significantly higher pod yield (0.207 kg plant$^{-1}$, 7.93 kg plot$^{-1}$ and 97.89 q ha$^{-1}$).The initial and post-harvest soils were analysed for their physico-chemical properties by adopting standard procedures. Hence, from this course of investigation it can be concluded that for getting, higher yield and available soil nutrients in french bean, the crop should be supplied with 75% NPK through inorganic source along with 25% N through vermicompost.

**Keywords:** pH, EC, OC, frenchbean, FYM, vermicompost

## Introduction
French bean (*Phaseolus vulgaris* L.) is an important leguminous vegetable crop which is a valuable source of protein as well as minerals and vitamin. It is characteristically shy of nitrogen fixation and require larger amount of nitrogen. French bean being a fertilizer responsive crop, respond well to nutrition, while excess nitrogen results in poor pod yield. Like other legumes, it also fixes atmospheric nitrogen and improves soil fertility. There is also report that french bean is insufficient in trapping atmospheric nitrogen due to lack of nodulation in north Indian plains, therefore, requires large quantity of nitrogenous fertilizer. It is well documented that higher level of nitrogen application not only seems to be uneconomic, but also endanger the basic production system. This situation warrants for a sustainable agro technology, through integrated plant nutrient supply system involving chemical, organic and biofertilizers.

A mixture of dung and urine of farm animals along with litter and left over material from roughages (Farm Yard Manure) is commonly used and most popular bulky manure rich in nutrients and improves soil fertility (Patel *et al*., 2012) [10].Vermicompost is an organic manure produced by earth worm feeding on biological waste material. It is odourless, clean, organic material containing adequate quantities of N, P, K and several micronutrients essential for plant growth. For achieving higher productivity and sustaining soil health, adoption of integrated nutrient management practices is necessary. Use of inorganic fertilizers not only increases the cost of production but also decreases over all soil fertility causing environmental pollution. Organic manure not only supplies the major nutrients, micronutrients, it also improves soil health. Application of inadequate and imbalanced nutrients results into low yield as well as poor quality. The organic fertilizers have proved that their application has the potential to increase the biomass and productivity of a wide range of crops. Therefore, keeping these facts in view, present study was undertaken to evaluate the influence of integrated nutrient management on soil properties in french bean.

## Materials and Methods

A field experiment was conducted 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 during *Rabi* season of 2018-19. The experiment was laid out in Randomized Block Design (RBD) with eight treatments replicated thrice. The eight treatment schedules were $T_1$ (100% NPK through inorganic source), $T_2$ (75% NPK through inorganic source + 25% N through FYM), $T_3$ (75% NPK through inorganic source + 25% N through vermicompost), $T_4$ (50% NPK through inorganic source + 50% N through FYM), $T_5$ (50% NPK through inorganic source + 50% N through vermicompost), $T_6$ (25% NPK through inorganic source + 75% N through FYM), $T_7$ (25% NPK through inorganic source + 75% N through vermicompost) and $T_8$ (control, no fertilizer). The soil of experimental field was sandy loam texture (sand: 65.4%, silt: 20% and clay: 14.6%) with 5.34 pH, 0.53 dSm-1 EC, 0.54 OC (%) and uniform topography. It had low available nitrogen (87.50 kg/ha), medium phosphorus (52.80kg/ha) and high potassium (266.20 kg/ha). Organic manures such as FYM were applied 7 days before sowing as per treatment requirement. Well decomposed vermicompost was incorporated in soil and mixed thoroughly as basal dose. Under each treatment, full dose of phosphorus, potash and half dose of nitrogen (through fertilizer) were applied as basal dose and the remaining half dose of nitrogen was applied one month after sowing. The source of nitrogen, phosphorus and potash were urea, SSP and MOP respectively. All cultural operations were performed as per recommendations. Sowing of healthy seed of Falguni variety of french bean was done with a spacing of 50 cm × 25 cm. Recommended agronomic and plant protection measures were followed for raising healthy crop. The yield of French bean were recorded and soil samples (0–15 cm) were collected from each plot after harvest of crop. These samples were analyzed for $p^H$ (1:2.5 soil: water suspension), organic carbon by rapid titration method (Walkley and Black, 1936), available N was estimated by alkaline permanganate method (Subbiah and Asija, 1956) [16], available P by Olsen's method (Olsen *et al*, 1954), available K by ammonium acetate extraction method (Jackson, 1967).The data were analyzed as per the standard procedure for Analysis of Variance (ANOVA) as described by Gomez and Gomez (1984). The significance of treatments were tested by 'F' test (Variance ratio). Standard error of mean (SEm±) was computed in all cases. The difference in the treatment mean was tested by using critical difference (CD) at 5% level of probability.

## Results and Discussion

### Yield parameters

### Average yield per plant (kg plant$^{-1}$)

The data recorded on the average yield per plant in French bean were statistically analyzed and presented in Table 1. The perusal of data in Table 1 revealed that application of different treatments during the field experiment significantly influenced the average pod yield per plant. It was noticed that the average pod yield per plant of French bean varied significantly ranging from 0.090 kg in T8 to maximum of 0.207 kg in $T_3$ with a mean value of 0.178 kg. Treatment $T_2$ (0.202 kg), $T_5$ (0.195 kg) and $T_4$ (0.188 kg) were found statistically at par with T3 (0.207 kg). 4.3.2.

### Total yield per plot (kg plot$^{-1}$)

Result data presented in Table 1 revealed significant variations in yield plot$^{-1}$ for french bean, due to integrated nutrient management. The pod yield plot$^{-1}$ ranged from 4.57 kg ($T_8$) to maximum of 7.93 kg ($T_3$) with a mean value of 6.71 kg. The plot received the treatment, $T_3$ recorded significantly highest pod yield plot$^{-1}$ of 7.93 kg closely followed by $T_2$ (7.57 kg), $T_5$ (7.40 kg) and $T_4$ (7.07 kg) which were statistically at par with each other**.**

### Yield per ha (q ha$^{-1}$)

A perusal to Table 1 revealed significant variations in yield per hectare (q ha$^{-1}$) in French bean, due to integrated nutrient management practices. The pod yield ranged from 56.41 q ha$^{-1}$ (T8) to maximum of 97.89 q ha$^{-1}$ (T3) with a mean value of 82.86 q ha$^{-1}$. The plot received the treatment $T_3$ recorded significantly highest pod yield of 97.89 q ha$^{-1}$ than rest of the treatments except $T_2$ (93.45 q ha-1), $T_5$ (91.35 q ha$^{-1}$) and $T_4$ (87.28 q ha$^{-1}$) which were *statistically at par*.

The results on yield parameters of french bean include average yield per plant, total yield per plot and yield per hectare varied significantly due to application of different integrated nutrient management practices. Significantly maximum average pod yield per plant was recorded by the application of 75% NPK through inorganic source + 25% N through vermicompost ($T_3$) followed by application of 75% NPK through inorganic source + 25% N through FYM ($T_2$) and 50% NPK through inorganic source + 50% N through vermicompost ($T_5$) than rest of the treatments. Similar trend was also observed in total yield per plot and yield per hectare. This might be due to significantly higher vegetative growth and yield attributing parameters in these treatments as noticed in the present study. Further it has already been established that integrated use of inorganic fertilizers along with organic manures (FYM or vermicompost) was always superior and would have provide to both macro and micro nutrients specification in optimum which in turn creates favourable environment for growth and development of the crop. The above findings are in harmony with Subbarayappa *et al*. (2009) [17] in cowpea, Masanta and Biswas (2009) [8] in french bean, Chauhan *et al*. (2010) [3] and Sepehya *et al*. (2012) [14] in garden pea, Mukesh *et al*. (2012) [10] and Reddy *et al*. (2014) [12] in cluster bean, Kamble *et al*. (2016) [6], Kumar and Pandita (2016) [7], Singh and Kumar (2016) [15] and Mohanty *et al*. (2017) [9] in french bean.

### Chemical properties of post-harvest soil of french bean

The results of the initial and post–harvest soil properties in an experiment with French bean were given below. Before application of manures and fertilizers an initial soil sample was collected and analysed for their $P^H$, EC and OC which were 5.34, 0.53 dSm$^{-1}$ and 0.54%, respectively. The soil used in this experiment belongs to sandy loam in texture.

### Soil PH

The data presented in Table 2 revealed that application of inorganic fertilizers with or without organic manures like FYM and vermicompost had no significant effect on soil PH. The lowest soil $P^H$ of 5.36 was recorded due to control treatment ($T_8$) and the highest (5.59) was recorded in $T_2$ with an average soil $P^H$ of 5.50. This was due to the fact that quantity and nature of fertilizers being applied are such that they don't alter the soil $P^H$ appreciably. Similar results were found by Santhy *et al*. (1999) [13], they reported that continuous addition of varying quantities and combination of NPK + FYM did not alter the Soil $P^H$ appreciably.

**Electrical conductivity (dSm$^{-1}$)**

The data pertaining to soil EC presented in Table 2 indicated that application of inorganic fertilizers with or without organic manures like FYM and vermicompost had no significant effect in French bean. The lowest electrical conductivity of 0.52 dSm$^{-1}$ was recorded in control treatment ($T_8$) and the highest was recorded in $T_2$ (0.60 dSm-1) with an average of 0.56 dSm$^{-1}$. This can be ascribed to the fact that the use of organic manure increases the micro flora altering EC of soil by reducing salt content. Similar results were also recorded by Santhy *et al*. (1999) [13] who noted a slight increase in salt content with application of 100% NPK + FYM and application of inorganic fertilizers alone.

**Organic carbon content (%)**

The data presented in Table 2 revealed that application of inorganic fertilizers with or without organic manures like FYM and vermicompost had significant effect on organic carbon content of soil. Significantly higher organic carbon content of 0.68% was recorded in $T_6$ than rest of the treatments, except $T_4$ (0.65%) and $T_7$ (0.66%) where *statistical parity* was observed. Chemical fertilizer applied treatment gave significantly less organic carbon than rest of the treatments except control. It was also noted that the organic sources retained higher residual OC in soil and there was further addition in organic matter due to residues after harvest of French bean crop. Increased dose of organic manures along with decreased doses of inorganic fertilizers improved soil organic carbon in comparison to application of chemical fertilizers alone in long term experimentation was reported by Bedi and Dubey (2009) [2].

**Available nitrogen (kg ha$^{-1}$)**

Data pertaining to available nitrogen in soil after harvest of French bean crop was presented in Table 2. Perusal of data revealed that the application of integrated nutrient management in French bean significantly influenced the available nitrogen content of the soil over its initial status. Significantly highest nitrogen availability was recorded in $T_3$ (176.5 kg ha$^{-1}$) as compared to rest of the treatments except $T_2$ (172 kg ha$^{-1}$) and $T_1$ (169.56 kg ha$^{-1}$) which were *statistically at par*. The lowest N availability of 89.33 kg ha$^{-1}$ was recorded in control treatment ($T_8$). Since it is a leguminous crop, the post harvest available N content in soil significantly increased over its initial content due to fixation of nitrogen in soil depending upon various treatments. However, available N in soil was comparatively lower where higher amount of organic nutrient source was applied. Increase in available N particularly chemical treatment may be due to sufficient supply of readily soluble nitrogen through applied fertilizers. Rao (1996) also reported that application of 100% RDF with vermicompost increase available N content in soil. This was due to the addition of chemical nitrogen along with organic sources narrowed the C:N ratio of organic manures that enhanced the rate of mineralization resulting in rapid release of nutrients.

**Available phosphorus (kg ha$^{-1}$)**

Data pertaining to available phosphorus in soil after harvest of french bean crop presented in Table 2 showed significant variations among different treatments. The available P content in soil varied significantly ranging from 30.50 kg ha$^{-1}$ ($T_8$) to 59.65 kg ha$^{-1}$ ($T_3$) due to various treatments. Significantly highest P availability was reported with T3 (59.65 kg ha$^{-1}$) as compared to rest of the treatments except $T_2$ (58.30 kg ha$^{-1}$) and $T_1$ (57.97 kg ha$^{-1}$) which were *statistically at par*. The lowest P availability of 30.50 kg ha$^{-1}$ was recorded in control treatment where no fertilizers were applied.

**Available potassium (kg ha$^{-1}$)**

The Data regarding potash availability in soil after harvest of french bean crop presented in Table 2 indicated that significantly highest K availability was recorded in $T_3$ (384.27 kg ha$^{-1}$) as compared to rest of the treatments except $T_2$ (382.17 kg ha$^{-1}$) and $T_1$ (375.07 kg ha$^{-1}$) which were *statistically at par*. The lowest K availability of 205.33 kg ha$^{-1}$ was recorded in control treatment ($T_8$).The increase in availability of P and K in these treatments might be due to higher quantity of P and K applied through inorganic source compared to rest of the treatments. The lowest available P and K in soil less than the initial value was recorded in control treatment where no fertilizers were applied. These findings are in confirmation with the findings of Band *et al*. (2007), Masanta and Biswas (2009) [8] and Metkari and Dhok (2011) in French bean, Gopinath and Milna (2011) in garden pea and Asha *et al*. (2017) in cluster bean.

**Conclusion**

Based on the results of the experiment, it is concluded that 75% NPK through inorganic source along with 25% N through vermicompost may be recommended as an effective package of practice to boost yield of french bean with sustaining soil health.

**Table 1:** Effect of Integrated Nutrient Management on yield parameters of French bean

| Treatment | | Average yield per plant (kg/plant) | Total Yield per plot (kg/plot) | Yield per ha (q/ha) |
|---|---|---|---|---|
| $T_1$ | 100% NPK through inorganic source | 0.186 | 6.56 | 80.98 |
| $T_2$ | 75% NPK through inorganic source + 25% N through FYM | 0.202 | 7.57 | 93.45 |
| $T_3$ | 75% NPK through inorganic source + 25% N through Vermicompost | 0.207 | 7.93 | 97.89 |
| $T_4$ | 50% NPK through inorganic source + 50% N through FYM | 0.188 | 7.07 | 87.28 |
| $T_5$ | 50% NPK through inorganic source + 50% N through Vermicompost | 0.195 | 7.40 | 91.35 |
| $T_6$ | 25% NPK through inorganic source + 75% N through FYM | 0.176 | 6.10 | 75.30 |
| $T_7$ | 25% NPK through inorganic source + 75% N through Vermicompost | 0.180 | 6.50 | 80.24 |
| $T_8$ | control (no fertilizer) | 0.090 | 4.57 | 56.41 |
| | Mean | 0.178 | 6.71 | 82.86 |
| | SE (m) + | 0.01 | 0.42 | 4.99 |
| | CD (5%) | 0.02 | 1.27 | 15.14 |
| | CV | 5.23 | 10.79 | 10.79 |

**Table 2:** Effect of Integrated Nutrient Management on available soil nutrients of French bean

| Treatment | | Soil pH | EC ($dSm^{-1}$) | Organic carbon (%) | Nitrogen ($Kg\ ha^{-1}$) | Phosphorus ($Kg\ ha^{-1}$) | Potassium ($Kg\ ha^{-1}$) |
|---|---|---|---|---|---|---|---|
| Initial soil | | 5.34 | 0.53 | 0.54 | 87.50 | 52.80 | 266.20 |
| T1 | 100% NPK through inorganic source | 5.53 | 0.59 | 0.58 | 169.57 | 57.97 | 375.07 |
| T2 | 75% NPK through inorganic source + 25% N through FYM | 5.59 | 0.60 | 0.59 | 172.00 | 58.30 | 382.17 |
| T3 | 75% NPK through inorganic source + 25% N through Vermicompost | 5.56 | 0.59 | 0.58 | 176.50 | 59.65 | 384.27 |
| T4 | 50% NPK through inorganic source + 50% N through FYM | 5.51 | 0.58 | 0.65 | 125.00 | 46.70 | 338.00 |
| T5 | 50% NPK through inorganic source + 50% N through Vermicompost | 5.50 | 0.55 | 0.60 | 130.83 | 49.15 | 343.77 |
| T6 | 25% NPK through inorganic source + 75% N through FYM | 5.48 | 0.54 | 0.68 | 100.00 | 33.85 | 275.33 |
| T7 | 25% NPK through inorganic source + 75% N through Vermicompost | 5.45 | 0.53 | 0.66 | 112.50 | 36.30 | 281.47 |
| T8 | control (no fertilizer) | 5.36 | 0.52 | 0.58 | 89.33 | 30.50 | 205.33 |
| | Mean | 5.50 | 0.56 | 0.61 | 134.47 | 46.55 | 323.18 |
| | SE (m) + | 0.11 | 0.03 | 0.02 | 2.45 | 1.26 | 8.04 |
| | CD (5%) | NS | NS | 0.06 | 7.427 | 3.82 | 24.38 |
| | CV | 3.50 | 7.87 | 5.76 | 3.16 | 4.69 | 4.31 |

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