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# Effect of integrated nutrient management on physiological parameters in French bean

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**Abstract**
The present investigation was conducted at the Horticultural Research cum Instructional Farm, IGKV, Raipur (C.G.) during the year 2020-21 and 2021-22 in *Rabi* season. The experiment was comprised of with eight treatments i.e. $T_1$: 75% RDF + 2.5 t FYM $ha^{-1}$, $T_2$: 50% RDF + 5.0 t FYM, $T_3$: 25% RDF + 7.5 t FYM, $T_4$: 75% RDF + 1 t vermicompost, $T_5$: 50% RDF + 2 t vermicompost, $T_6$: 25% RDF + 3 t vermicompost, $T_7$: Recommended doses of fertilizer and $T_8$: Control (without application) which were laid out in randomize block design with three replications. Result revealed that the physiological parameters i.e. relative growth rate (5.56, 5.04 and 5.30 g $g^{-1}$ $day^{-1}$ $m^{-2}$) and crop growth rate (0.75, 0.68 and 0.72 g $day^{-1}$ $m^{-2}$) recorded higher under 75% RDF + 1 t vermicompost during both the year and pooled mean. While, absolute growth rate (g $day^{-1}$) and crop water use efficiency (kg ha $mm^{-1}$) recorded higher under 75% RDF + 1 t vermicompost and 75% RDF + 2.5 t FYM during. All physiological parameters were recorded minimum under control (without application).

**Keywords:** French bean, INM, physiological parameters, RGR, CGR, AGR and WUE

## Introduction
French bean (*Phaseolus vulgaris* L.), is one of the most important and widely cultivated legume crops on the globe. It is commonly known by different names such as snap bean, string bean, kidney bean, haricot bean, fresh bean, navy bean etc. The crop thrives well in diverse environments of the world ranging from tropical to temperate regions (Mongi *et al.*, 2016) [4]. Its pods are used as a green vegetable, green shelled, or dry as pulses according to stage of harvest. French bean is an excellent source of protein. India is the second largest producer of vegetables next to China in the world. In India, it is grown in an area of 9.575 million hectares with the productivity of 17.7 MT/ha which contributes around 14% of the total world production (Anonymous, 2017) [1]

The modern day intensive crop cultivation requires the use of chemical fertilizers. But, the price of inorganic fertilizers has gone up considerably which in turn has increased the cost of production. Use of inorganic fertilizers not only increased the cost of production but also decreased over all soil fertility causing environmental pollution. The excessive use of chemical fertilizer in field deteriorates the soil health. The solution of such an alarming issue probably lies in use of organic manures either solely or in combination with the chemical fertilizers (Ramana *et al.*, 2010) [5]. Considering the fact that organic manures heal the soil attributes and with slow release of nutrients compared to that of quick availability by inorganic fertilizers, an integrated approach by combination of both the component of chemical fertilizer with organic manure can be a possible solution to this (Datt *et al.*, 2013) [2]. The combined use of organic and chemical fertilizer not only increases the yield of crop but improve the physical, chemical and biological properties of soil. Use of organic manure with optimum rate of fertilizer under intensive farming system increased the turnover of nutrients in the soil plant system (Metkari and Dhok, 2011) [3]. Therefore, considering the fact that organic manures heal the soil attributes with releases of nutrients, an integrated approach of organic and inorganic sources of nutrients has proved excellent to individual components with respect to growth, yield and quality of pulses.

## Materials and Methods
The experiment was carried out during rabi season of 2020-21 and 2021-22 at the Horticultural Research cum Instructional Farm, IGKV, Raipur (C.G.). The experiments were carried out in Randomized Block Design (RBD) with three replications.

In each replication eight treatments viz., $T_1$ : 75% RDF + 2.5 t FYM $ha^{-1}$, $T_2$ : 50% RDF + 5.0 t FYM, $T_3$ : 25% RDF + 7.5 t FYM, $T_4$ : 75% RDF + 1 t vermicompost, $T_5$ : 50% RDF + 2 t vermicompost, $T_6$ : 25% RDF + 3 t vermicompost, $T_7$ : Recommended doses of fertilizer and $T_8$ : Control (without application) were allocated. The schedules of various cultural operations were carried out during the course of investigation according to need and time of operation. The physiological parameters *i.e.* relative growth rate (RGR), crop growth rate (CGR), absolute growth rate (AGR) and crop water use efficiency were measured during course of investigation.

**1. Relative growth rate (RGR):** It's a measure of how much growth material there is per unit dry weight of plant per unit time. It is also called efficiency index.

$$RGR\ (g\ g^{-1}\ day^{-1}\ m^{-2}) = \frac{LnW_2 - LnW_1}{(t_2 - t_2)}$$

**2. Crop growth rate (CGR):** It represents the crops overall growth rate per unit time, inspection of the previous growth rate. Following is the formula for calculation of CGR:

$$CGR\ (g\ day^{-1}\ m^{-2}) = \frac{W_2 - W_1}{P\ (t_2 - t_1)}$$

**3. Absolute growth rate (AGR):** Absolute Growth Rate (AGR), if referred to the size of a plant, represents the increase in its mass per unit of time:

**4. Crop water use efficiency:** Water utilization by the crop is generally described in terms of water use efficiency (q $ha^{-1}$-cm). Water use efficiency was calculated by dividing total pod yield with total water used by the crop.

$$\text{Water use efficiency (q ha}^{-1}\text{-cm)} = \frac{Y}{\text{Water used by the crop}}$$

The data were statistically analysed using Randomized Block Design with three replications, based on the mean of individual plants chosen for observation to determine the overall total variability present in the material under study for each character and for all populations. Wherever the F-test was found to be significant at the 5% level of probability, critical difference values were calculated.

## Result and Discussions

### Relative growth rate (g $g^{-1}$ $day^{-1}$ $m^{-2}$)

The application of different combination of RDF and organic fertilizer was found non-significant with respect to relative growth rate (g $g^{-1}$ $day^{-1}$ $m^{-2}$). The data on the mean relative growth rate (g $g^{-1}$ $day^{-1}$ $m^{-2}$) are presented in Table 1 and depicted graphically in Fig. A.

Among the treatments, maximum relative growth rate (g $g^{-1}$ $day^{-1}$ $m^{-2}$) (5.56, 5.04 and 5.30 g $g^{-1}$ $day^{-1}$ $m^{-2}$) was recorded in $T_4$ - 75% RDF + 1 t vermicompost during 2020-21, 2021-22 and in mean data, respectively. This was *at par* with $T_1$ - 75% RDF + 2.5 t FYM (5.11 g $g^{-1}$ $day^{-1}$ $m^{-2}$) and $T_5$ - 50% RDF + 2 t vermicompost (4.96 g $g^{-1}$ $day^{-1}$ $m^{-2}$) during 2020-21, $T_5$ - 50% RDF + 2 t vermicompost (4.89 g $g^{-1}$ $day^{-1}$ $m^{-2}$), $T_1$ - 75% RDF + 2.5 t FYM (4.07 g $g^{-1}$ $day^{-1}$ $m^{-2}$) and $T_2$ - 50% RDF + 5.0 t FYM (3.98 g $g^{-1}$ $day^{-1}$ $m^{-2}$) during 2021-22 and $T_5$ - 50% RDF + 2 t vermicompost (4.93 g $g^{-1}$ $day^{-1}$ $m^{-2}$) and $T_1$ - 75% RDF + 2.5 t FYM (4.59 g $g^{-1}$ $day^{-1}$ $m^{-2}$) in mean data. However, minimum relative growth rate (g $g^{-1}$ $day^{-1}$ $m^{-2}$) (3.48, 3.04 and 3.26 g $g^{-1}$ $day^{-1}$ $m^{-2}$) was recorded in $T_8$ - Control (without application) during 2020-21, 2021-22 and in mean data, respectively.

### Crop growth rate (g $day^{-1}$ $m^{-2}$)

The application of different combination of RDF and organic fertilizer was found non-significant with respect to crop growth rate (g $day^{-1}$ $m^{-2}$). The data on the mean crop growth rate (g $day^{-1}$ $m^{-2}$) are presented in Table 1 and depicted graphically in Fig. B.

Among the treatments, maximum crop growth rate (g $day^{-1}$ $m^{-2}$) was recorded (0.75, 0.68 and 0.72 g $day^{-1}$ $m^{-2}$) in $T_4$ - 75% RDF + 1 t vermicompost during 2020-21, 2021-22 and in mean data, respectively. This was *at par* with $T_5$ - 50% RDF + 2 t vermicompost (0.69 g $day^{-1}$ $m^{-2}$) and $T_1$ - 75% RDF + 2.5 t FYM (0.67 g $day^{-1}$ $m^{-2}$) during 2020-21, $T_1$ - 75% RDF + 2.5 t FYM (0.66 and 0.67 g $day^{-1}$ $m^{-2}$) during 2021-22 and in mean data. However, minimum crop growth rate (g $day^{-1}$ $m^{-2}$) (0.47, 0.41 and 0.44 g $day^{-1}$ $m^{-2}$) was recorded in $T_8$ - Control (without application) during 2020-21, 2021-22 and in mean data, respectively.

### Absolute growth rate (g $day^{-1}$)

The application of different combination of RDF and organic fertilizer was found non-significant with respect to absolute growth rate (g $day^{-1}$). The data on the absolute growth rate (g $day^{-1}$) are presented in Table 2 and depicted graphically in Fig. C.

Among the treatments, maximum absolute growth rate (g $day^{-1}$) (0.045 g $day^{-1}$) was recorded in $T_4$ - 75% RDF + 1 t vermicompost during 2020-21 and (0.048 and 0.046 g $day^{-1}$) in $T_1$ - 75% RDF + 2.5 t FYM during 2021-22 and in mean data, respectively. This was *at par* with $T_1$ - 75% RDF + 2.5 t FYM (0.045 g $day^{-1}$), $T_5$ - 50% RDF + 2 t vermicompost (0.044 g $day^{-1}$), $T_2$ - 50% RDF + 5.0 t FYM (0.044 g/day) and $T_6$ - 25% RDF + 3 t vermicompost (0.043 g $day^{-1}$) during 2020-21, $T_4$ - 75% RDF + 1 t vermicompost (0.043 g $day^{-1}$) during 2021-22 and $T_4$ - 75% RDF + 1 t vermicompost (0.046 g $day^{-1}$), $T_5$ - 50% RDF + 2 t vermicompost (0.042 g $day^{-1}$), $T_2$ - 50% RDF + 5.0 t FYM (0.041 g $day^{-1}$) and $T_6$ - 25% RDF + 3 t vermicompost (0.040 g $day^{-1}$) in mean data. However, minimum absolute growth rate (g $day^{-1}$) (0.036, 0.034 and 0.035 g $day^{-1}$) was recorded in $T_8$ - Control (without application) during 2020-21, 2021-22 and in mean data, respectively.

### Crop water use efficiency (kg $ha^{-1}mm^{-1}$)

The application of different combination of RDF and organic fertilizer was found non-significant with respect to crop water use efficiency (kg $ha^{-1}mm^{-1}$). The data on the crop water use efficiency (kg $ha^{-1}mm^{-1}$) are presented in Table 2 and depicted graphically in Fig. D.

Among the treatments, maximum crop water use efficiency (kg $ha^{-1}mm^{-1}$) (43.55 kg $ha^{-1}mm^{-1}$) was recorded in $T_1$ - 75% RDF + 2.5 t FYM during 2020-21 and 51.66 and 47.45 kg $ha^{-1}mm^{-1}$ in $T_4$ - 75% RDF + 1 t vermicompost during 2021-22 and in mean data, respectively. However, minimum crop water use efficiency (kg $ha^{-1}$ $mm^{-1}$) (34.48, 39.30 and 36.89 kg $ha^{-1}$ $mm^{-1}$) was recorded in $T_8$ - Control (without application) during 2020-21, 2021-22 and in mean data, respectively.

**Table 1:** Effect of integrated nutrient management on relative growth rate, crop growth rate, absolute growth rate and crop water use efficiency of french bean

| Treatment | Relative growth rate ($g^{-1}g^{-1}day^{-1}$) | | | Crop growth rate ($g/m^2$) | | |
|---|---|---|---|---|---|---|
| | 2020-21 | 2021-22 | Mean | 2020-21 | 2021-22 | Mean |
| $T_1$ - 75% RDF + 2.5 t FYM | 5.11 | 4.07 | 4.59 | 0.67 | 0.66 | 0.67 |
| $T_2$ - 50% RDF + 5.0 t FYM | 4.72 | 3.98 | 4.35 | 0.64 | 0.54 | 0.59 |
| $T_3$ - 25% RDF + 7.5 t FYM | 3.51 | 3.88 | 3.69 | 0.61 | 0.44 | 0.53 |
| $T_4$ - 75% RDF + 1 t vermicompost | 5.56 | 5.04 | 5.30 | 0.75 | 0.68 | 0.72 |
| $T_5$ - 50% RDF + 2 t vermicompost | 4.96 | 4.89 | 4.93 | 0.69 | 0.55 | 0.62 |
| $T_6$ - 25% RDF + 3 t vermicompost | 4.32 | 3.28 | 3.80 | 0.58 | 0.52 | 0.55 |
| $T_7$ - Recommended doses of fertilizer | 4.49 | 3.17 | 3.83 | 0.47 | 0.43 | 0.45 |
| $T_8$ - Control (without application) | 3.48 | 3.04 | 3.26 | 0.47 | 0.41 | 0.44 |
| SEm ± | 0.34 | 0.35 | 0.34 | 0.03 | 0.04 | 0.04 |
| CD (p=0.05) | 1.02 | 1.06 | 1.00 | 0.10 | 0.13 | 0.11 |

**Table 2:** Effect of integrated nutrient management on relative growth rate, crop growth rate, absolute growth rate and crop water use efficiency of french bean

| Treatment | Absolute growth rate (g $day^{-1}$) | | | Crop water use efficiency (kg $^{-1}ha^{-1}/mm^{-1}$) | | |
|---|---|---|---|---|---|---|
| | 2020-21 | 2021-22 | Mean | 2020-21 | 2021-22 | Mean |
| $T_1$ - 75% RDF + 2.5 t FYM | 0.045 | 0.048 | 0.046 | 43.55 | 48.42 | 45.99 |
| $T_2$ - 50% RDF + 5.0 t FYM | 0.044 | 0.039 | 0.041 | 41.77 | 43.38 | 42.58 |
| $T_3$ - 25% RDF + 7.5 t FYM | 0.042 | 0.034 | 0.038 | 35.82 | 41.62 | 38.72 |
| $T_4$ - 75% RDF + 1 t vermicompost | 0.049 | 0.043 | 0.046 | 43.23 | 51.66 | 47.45 |
| $T_5$ - 50% RDF + 2 t vermicompost | 0.044 | 0.039 | 0.042 | 42.09 | 49.12 | 45.61 |
| $T_6$ - 25% RDF + 3 t vermicompost | 0.043 | 0.038 | 0.040 | 36.27 | 41.56 | 38.92 |
| $T_7$ - Recommended doses of fertilizer | 0.040 | 0.038 | 0.039 | 39.70 | 40.71 | 40.21 |
| $T_8$ - Control (without application) | 0.036 | 0.034 | 0.035 | 34.48 | 39.30 | 36.89 |
| SEm ± | 0.002 | 0.002 | 0.002 | 2.60 | 2.26 | 2.44 |
| CD (p=0.05) | 0.006 | 0.008 | 0.007 | NS | 6.85 | 7.06 |

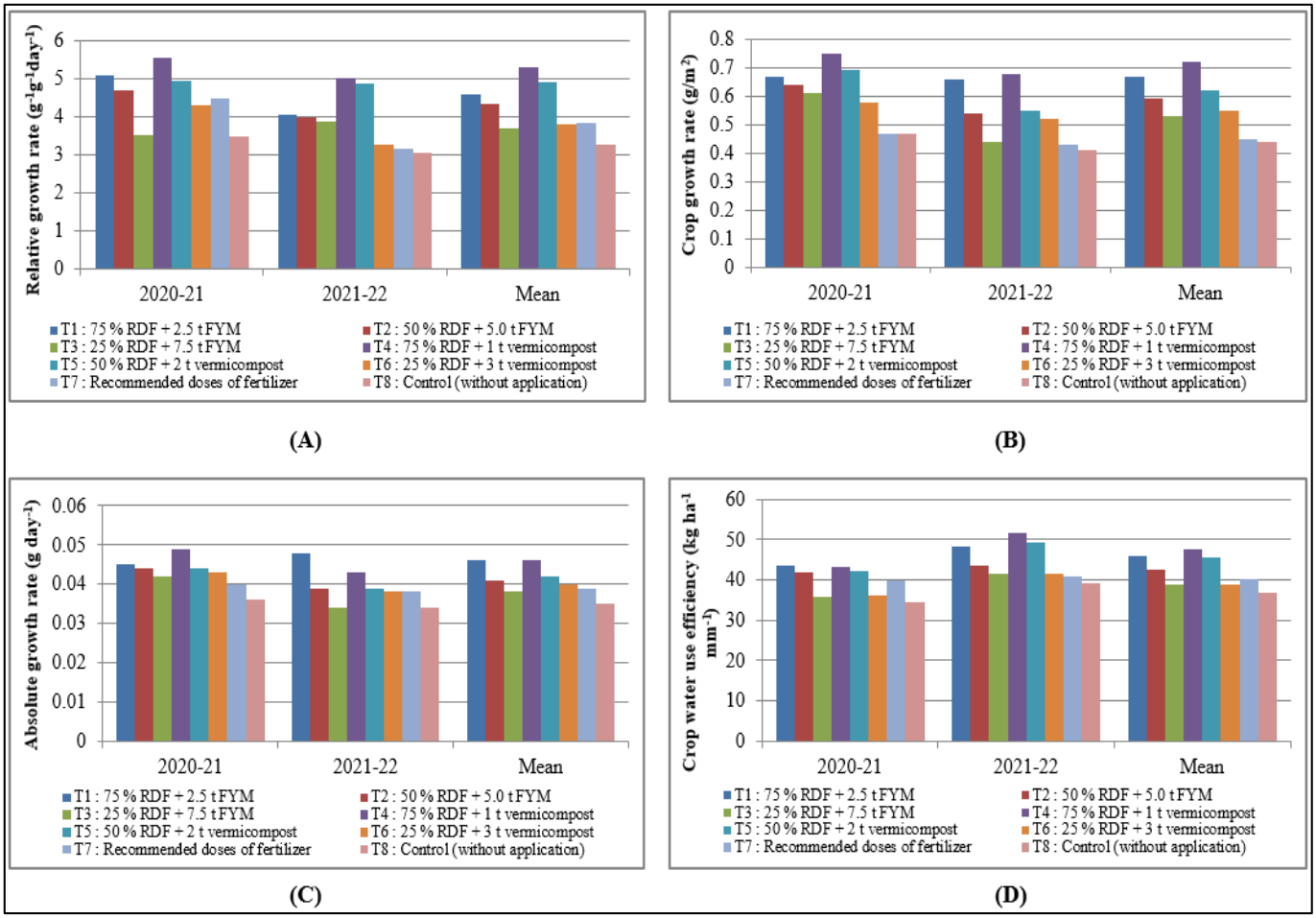


**Fig:** Effect of integrated nutrient management on (A) relative growth rate, (B) crop growth rate, (C) absolute growth rate and (D) crop water use efficiency.

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