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Influence of integrated nutrient management on growth attributes of French bean (*Phaseolus vulgaris* L.)

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Abstract
Aims: This study was undertaken to evaluate the influence of integrated nutrient management on Growth attributes of French bean.
Study Design: The experiment was laid out in randomized block design with three replications. The treatments consist of seven nutrient levels viz., T_1: 75% RDF + 25% (N) Vermicompost (1250 kg/ha), T_2: Vermicompost (10 t/ha) + *Rhizobium* (15 g/kg seed) + PSB 75% RDF + 25% (N) FYM (2000 kg/ha) + Bio-fertilizer (Rhizobium+PSB), T_3: 75% RDF + 25% (N) Vermicompost (1250 kg/ha) + Bio-fertilizer (Rhizobium+PSB), T_4: 75% RDF + 12.5% (N) FYM (1000 kg/ha) + 12.5% (N) Vermicompost (625 kg/ha) + Bio-fertilizer (Rhizobium+PSB), T_5: 100% RDF (Chemical fertilizer), T_6: 100% RDF (N) Organic Matter (8000 kg/ha FYM), T_7: Absolute control and Swarna Priya variety was taken.
Place and duration of study: The experiment was carried out in the Experimental farm of Department of Horticulture, Ranchi Agriculture College, Birsa Agricultural University, Kanke, Ranchi during *rabi* season 2018-19.
Methodology: Biofertilizer viz. *Rhizobium* and PSB (Phosphorus Solubilising Bacteria) cultures were applied as seed treatment. Well decomposed vermicompost was incorporated in soil and mixed thoroughly as basal dose. Full dose of phosphorus, potash and ½ dose of nitrogen were applied as basal dose and ½ dose of nitrogen was applied as split one month after sowing. The source of nitrogen, phosphorus and potash were urea, DAP and MOP, respectively. Sowing of healthy seed was done at a spacing of 40 cm × 10 cm. Recommended agronomic and plant protection practices were followed for raising healthy crop.
Results: The findings revealed significant effect of nutrient levels on vegetative traits of French bean. Among the different treatments, T_3 (75% RDF + 25% (N) Vermicompost (1250 kg/ha) + Bio-fertilizer (Rhizobium+PSB)) recorded highest plant height of 35.73cm, highest number of leaves (35.2), maximum leaf area of 143.2 cm^2 and maximum number of primary branches (14.9) at harvest. However highest germination percentage was observed in T_5 (100% RDF (Chemical fertilizer)) i.e. 92.67 percent. First flowering was earliest (36 DAS) in T_3 followed by and days to 50 percent flowering was earliest (42.33 DAS) in T_1 (75% RDF + 25% (N) Vermicompost (1250 kg/ha)). Days to harvest was seen earliest (65.5 DAS) in T_3 and last in T_7 (73.39 DAS).
Conclusion: Among different treatments, T_3 (75% RDF + 25% (N) Vermicompost (1250 kg/ha) + Bio-fertilizer (Rhizobium+PSB) resulted in superior vegetative traits. Though, it was late in days to 50 percent flowering and also it had lower percent of germination compared to T_5.

Keywords: French bean, integrated nutrient management, vegetative parameters

1. Introduction
French bean (*Phaseolus vulgaris* L.) 2n=22 of family Leguminoseae (Fabaceae) is a short duration and one of the most precious and highly relished vegetables in North India. Pulses constitute the major part of Indian vegetarian diet that fulfills major share of protein requirement of predominantly vegetarian population of India. In India, many pulse crops are grown like mung, urd, gram and among these French bean is most important. French bean is an excellent source of protein. It is widely grown bean because of its short duration and nutritious values. It is a valuable source of protein, vitamins and minerals. Hundred grams of green pods contain 22% protein, 78% of carbohydrates, 221 I.U. vitamin A, 11 mg vitamin C, 381 mg Calcium. It is rich in amino acids like tryptophan, methionine and some phenolic compounds like tannin and polyphenol oxidase [5]. Moreover, the protein of rajma has proved to be a quality protein for human consumption in the manner the soybean oil proved its worth.
French bean is assured crop which responds well to fertilization. It is especially characterized by lack of nodules though it is legume, due to absence of NOD gene regulator. It is inefficient in nitrogen fixation [3]. Therefore, it responds well to high nitrogen fertilization. There is a worldwide consensus that sole dependence on chemical input based agriculture is not suitable

in long run and only integrated plant nutrient systems (IPNS) involving a combination of fertilizer, organic manure and bio-fertilizers are essential to sustain crop production, preserve soil health and biodiversity. In addition to this, organic manures help in improving the use efficiency of inorganic fertilizers. Use of biofertilizers not only reduce the risk of environmental pollution but also bring the cost of cultivation. Vermicompost, FYM and biofertilizers are highly efficient organic manures, which can increase production and improve the quality of vegetables. These organic manures increase the fertility of land by increasing the NPK content, water holding capacity and productivity of soil. Organic manures have been the traditional means of maintaining soil fertility as it provides a balanced source of nutrient for crops and accelerate the biological activity. The advantage of combining organic and inorganic sources of nutrients in integrated nutrient management has been proved superior. Therefore, keeping these facts in view, present study was undertaken to evaluate the influence of integrated nutrient management on yield of French bean.

2. Materials and Method

A field experiment was conducted at Experimental farm of Department of Horticulture, Ranchi Agriculture College, Birsa Agricultural University, Kanke, Ranchi during *rabi* 2018-19. The mean annual precipitation of this region is 1400 mm of which 80-85 percent is received during June to September. Temperature of this region varies as low as 6.00 °C in winter to as high 37.70 °C in summer and April and May are the hottest months with an average maximum temperature of 37.70 °C and 36.80 °C, respectively while December and January are the coldest months of the year having temperature 6.00 °C. The relative humidity (R.H.) rises upto 87.00 per cent during November and February and falls down to 40.50 per cent during May

The soil of experimental field was sandy loam in texture (sand: 60.4%, silt: 20.0% and clay: 19.6%) with 6.1 pH, high in organic carbon (0.57%) and low to medium in nitrogen (229.79 Kg/ha), phosphorus (35.40 kg/ha) and potassium (237 Kg/ha). The experiment was carried out from Nov 2018 to March 2019 in Randomized Block Design (RBD) with 7 treatment replicated three times. The whole field was divided into three blocks, each representing a replication. The plot size was 9m x 9m and the spacing was 40cm x 10 cm. Treatments were allocated to each plot randomly using Fisher and Yates Random Number (1963).

Swarna Priya variety was taken for this experiment. Biofertilizer viz. *Rhizobium* and PSB (Phosphorus Solubilising Bacteria) were applied as seed treatment. Well decomposed vermicompost was incorporated in soil and mixed thoroughly as basal dose. Under each treatment, full dose of phosphorus, potash and ½ dose of nitrogen (if to be given through fertilizer) were applied as basal dose and ½ dose of nitrogen was applied as split 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 was done with spacing of 40 cm × 10 cm. Five plants form each plot were selected randomly and marked from each treatment to calculate number of pods per plant, length of pod, pod circumference, number of seeds per pod, seed length and yield of fresh pod per hectare.

Table 1: Treatment details

Treatment	Treatment details
T_1	75% RDF + 25% (N) Vermicompost (1.25 t/ha)
T_2	75% RDF + 25% (N) FYM (2000 kg/ha) + Bio-fertilizer (Rhizobium+PSB)
T_3	75% RDF + 25% (N) Vermicompost (1.25 t/ha) + Bio-fertilizer (Rhizobium+PSB)
T_4	75% RDF + 12.5% (N) FYM (1 t/ha) + 12.5% (N) Vermicompost (0.625 t/ha) + Bio-fertilizer (Rhizobium+PSB)
T_5	100% RDF (Chemical fertilizer)
T_6	100% RDF (N) Organic Matter (8 t/ha FYM)
T_7	Absolute control

Table 2: Cropping history of the experimental field

Years	Kharif	Rabi
2015-16	Tomato	Fallow
2016-17	Tomato	French bean

3. Result and Discussion

The result of the present study indicated that among the 7 different treatments, the treatment combination of T_3(75% RDF + 25% (N) Vermicompost (1.25 t/ha) + Bio-fertilizer (Rhizobium+PSB)) and T_4(75% RDF + 12.5% (N) FYM (1t/ha) + 12.5% (N) Vermicompost (0.625 t/ha) + Bio-fertilizer (Rhizobium+PSB)) recorded significant improvement in various growth parameters viz., germination percentage, plant height, number of leaves per plant, number of primary branches per plant, leaf area, days to first flowering, days to 50 percent flowering and days to harvest.

3.1. Germination percentage

Scrutiny of the data revealed that germination percentage was significantly affected by the different levels and sources of nutrients. Among different treatments, application of 100 percent chemical fertilizers resulted in significantly higher germination percentage (92.67%) over absolute control. During the trial the organic nitrogen mineralized slowly but steadily and supplied required quantity of usable nitrogen during progressive growth period but initial requirement of nitrogen would have been met from inorganic source, as it would have been available instantly to the plant. This types of investigation were done earlier by [1] in French bean.

3.2. Plant height

It was clearly evident from the data presented in Table 3 that due to different treatments different growth patterns in plant height were observed. The lowest plant height (23.93 cm) was observed in control however, the best plant height (35.73 cm) was observed in T_5, where application of 25% (N) vermicompost and bio-fertilizer along with 75% recommended dose of chemical fertilizer (RDF) influenced significantly the plant height. By comparing the treatments, it can be ascertained that application of vermicompost combined with bio-fertilizer in T_5 had influenced the growth by regulating the growth parameters, photosynthates, source sink relation etc. Also the bio-fertilizers might have produced some phytohormones, which helped to increase the plant height. Application of N P K increase the plant height to a greater extent, as nitrogen being a constituent of protoplasm

would increase cell division and multiplication while, potassium improves the photosynthetic activity and translocation of carbohydrates.
These findings are in harmony with the view of [2, 4, 8, 9, 11] in French bean.

3.3. Number of leaves and
3.3.1 Number of primary branches
The number of leaves and number of branches per plant produced uniform trend during the experiment. The number of branches were more with treatment having 75% RDF + 25% (N) Vermicompost + Biofertiizer (Rhizobium + PSB) and (75% RDF +12.5% (N) FYM + 12.5% (N) Vermicompost + Biofertilizer). Likewise, more number of leaves were also recorded with T_5 (35.2) and T_6 (33.3). It may be concluded that when number of branches increased mostly there was increase in number of leaves.
However, there were significant difference among the treatments in producing number of branches per plant and number of leaves per plant indicating that these two characters respond well to integrated nutrient management and management practices, environment, edaphic, climatic and nutrition factors had profound influence on these two characters during the course of investigation. This types of investigation were done earlier by [13, 14, 18] in French bean.

3.4. Leaf area
Average leaf area under various treatments ranged from 81.31cm^2 to 143.27cm^2 (Table 3). Application of 25% vermicompost and bio-fertilizer along with 75% recommended dose of chemical fertilizer (RDF) showed significant increase in leaf area than control. The large leaf area has high chlorophyll content that resulted in increase in the synthesis of carbohydrates. However, inorganic source alone could not steadily supply the nitrogen until harvest. The PSB might have increased phosphate availability in soil, which in turn, helped in better root growth and increased absorption of nutrient largely.
The results are in consonance with the reports of [10, 12, 17] in French bean.

3.5. Days to first flowering and days to 50% flowering
Days to first flowering was earliest (36 days) in treatment having 75% RDF + 25% Vermicompost + Biofertiizer (Rhizobium + PSB)) whereas, days to 50% flowering was earliest (42.33 days) in T_3 (75% RDF + 25%Vermicompost). Similarly maximum days to first flowering (51.33) was in T_3 and maximum days taken to 50% flowering (42.67 days) was in T_9. More or less same duration of days were required from first flowering to 50% flowering among the treatments. There was no significant changes in days to 50% flowering indicating that under proper management condition with favorable climate the days to 50% flowering did not vary much.
The present findings are in harmony with the findings of in French bean.

3.6. Days to Harvest
From the findings, the minimum days to harvest was 116.12 DAS in T_5 (75% RDF + 25% (N) Vermicompost (1.25 t/ha) + Bio-fertilizer (Rhizobium+PSB)) and the maximum days to harvest was 119.98 DAS in control (T_9).
Application of 25% vermicompost and bio-fertilizer along with 75% recommended dose of chemical fertilizer (RDF) might have produced some phytohormones which resulted in earliness in pod maturity. This is in consonance with [11].

Table 3: Effect of INM on growth parameters.

Treatment	Germination percentage	Plant Height	Leaf Area	No. of leaves	No. of primary branches	Days to first flowering	Days to 50% flowering	Days to harvest
T_1	91.33	29.53	129.20	30.23	12.58	37.00	42.33	116.74
T_2	92.00	29.67	123.39	30.60	12.01	38.33	47.66	116.12
T_3	92.33	35.73	143.27	35.20	14.90	36.00	43.33	114.98
T_4	91.67	31.27	130.65	33.33	14.13	37.33	44.66	118.08
T_5	92.67	26.40	98.75	26.44	10.51	38.67	45.33	121.93
T_6	89.67	25.13	101.25	27.78	11.10	41.00	48.66	119.93
T_7	85.00	23.93	81.31	27.48	10.08	42.67	51.33	123.40
Sem (±)	1.03	2.20	7.42	1.28	0.86	1.32	0.72	
CD (P=0.05)	3.17	6.78	22.86	3.93	2.64	4.07	2.23	NS
C V (%)	1.97	13.23	11.15	7.33	12.14	5.90	2.72	

4. Conclusion
It was observed that combination of organic and inorganic sources of fertilizer influenced growth attributing characters. The application of vermicompost and biofertilizer in some treatments performed better with suitable nutrient combination. It can be concluded that application of 75% RDF + 25% vermicompost along with biofertilizer produced better yield (97.93 q/ha) as compared to other treatments

5. Acknowledgement
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6. Conflict of Interest
There is no any conflict of interest between the authors with respect to their position of author name and any other issues.

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