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Research Article

PRODUCTIVITY AND QUALITY OF FRENCH BEAN (*PHASEOLUS VULGARIS* L.) AS INFLUENCED BY INTEGRATING VARIOUS SOURCES OF NUTRIENTS UNDER TEMPERATE CONDITIONS OF KASHMIR

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ABSTRACT
The present study was carried out at Research, Faculty of Agriculture, Wadura, Sopore, SKUAST-Kashmir (J&K) to study the effect of integrated nutrient management (INM) on productivity and quality of French bean under temperate conditions of Kashmir. Treatments included twelve combinations *viz.* T_2 (75% RDF), T_3 (100% RDF i,e 30:50:30 Kg NPK/ha, respectively), T_4 (125% RDF), T_5 (FYM), T_6 (VC), T_7 (Bio-fertilizer viz., Rh + PSB),T_8 (FYM (50%) +VC (50%) +Bio-fertilizer), T_9 (50% RDF + 50% FYM), T_{10} (50% RDF + 50% VC),T_{11} (50% RDF+ Bio-fertilizers), T_{12} (50% RDF + 25% FYM + VC 25% VC + Bio-fertilizer), besides an absolute control i.e., T_1 (no organic, inorganic and bio-fertilizer applied) and was laid out in Randomized Block Design with three replications. Results revealed that the yield attributes and yield increased significantly over control and highest pods/plant (13.40), seeds/pod (5.00), pod length (11.01 cm), 100-seed weight (g) and seed yield (1386.67 kg/ha) were recorded with application of 125% RDF but showed no significant difference with treatment (T12) involving substitution of 50% RDF through 25% FYM + 25%VC + biofertilizer (1.5 ton FYM/ha + 0.55 ton VC/ha + 20 g biofertilizer/kg seed). Highest growth and quality parameters (plant height (33.50 cm), primary branches (4.80, secondary branches (4.40), LAI (5.77), total dry weight (22.00), protein content (21.20%) and protein yield (294.01 kg/ha) were also recorded with application of 125% RDF and lowest in control. Thus, growth and yield may be improved by integrated use of organic and inorganic sources of nutrient and the nutrient management.

***Keywords**: French Bean, Nutrients, Organic, Biofertilizers, Growth and Yield*

INTRODUCTION
French bean (*Phaseolus vulgaris*) is a short duration, non-traditional legume and is one of the precious and highly relished pulse crop of North India with a high yield potential of 18-20 q/ha. It is commonly known by various names *viz*., rajmash, rajma, haricot bean, field bean, kidney bean, snap bean, pole bean etc. It is a cheap source of vegetable protein, vitamins and minerals like calcium and iron. With population explosion, the demand for the crop has increased significantly, leading to the extensive use of chemical fertilizers without any consideration for soil health and quality, which is a critical factor for realizing sustainable yield. Besides, the residual effects of chemical fertilizers on environment, underground water, soil microbes and the crop products is a matter of concern. High use of the chemical fertilizers not only puts a heavy financial burden to the growers but gradually decreases the partial productivity and thereby, jeopardizes the sustenance of the basic system. Inadequate use of the organic manures has also rendered Indian soils deficient in macro and micro nutrients (Acharya and Mandal, 2002). Organic manures are eco-friendly, cheap source of nutrients and are potentially sound for supplying nutrients which can reduce dependence on chemical fertilizers (Datt *et al.*, 2013). Organic resources are largely biological in origin and they have several nutrients in their composition, which on decomposition are released into soil (Kumar *et al.*, 2014). Organic sources of the plant nutrients have been reported to improve nutritional quality, protein content and mineral content in crops as compared to those with inorganic sources (Bhadoria *et al.*, 2002). Thus, for increasing the yield and quality of French bean, besides other factors, an adequate quantity of nutrients from organic and inorganic sources is pre-

requisite. Keeping this in view, the present investigation was planned to study the effect of integrated nutrient management on growth, yield and quality of French bean.

MATERIALS AND METHODS

Field experiment was conducted during *kharif* 2012 at Research Farm of the Department of Agronomy, Faculty of Agriculture, Wadura, Sopore, SKUAST-Kashmir located at 34^0 172 N and 72^0 332 E at an altitude of 1524 m above MSL, to study the effect of integrated nutrient management on growth, yield and quality of French bean. The experimental soil was well drained silty clay loam in texture with pH 7.4, high in inorganic C 0.86% (Walkley and Black, 1934), medium in available N 317.4 kg/ha (Subbiah and Asija, 1954), available P 19.2 kg/ha (Olsen *et al.*, 1954) and available K 248.5 kg/ha (Jackson, 1967). The experiment was laid out in a Randomized Block Design having 12 treatments (Table-1), comprising different combinations of inorganic fertilizers, organic manure and biofertilizers *viz*, 75% RDF (T_2), 100% RDF (T_3), 125% RDF (T_4), FYM (T_5), VC (T_6), Bio-fertilizer viz., *Rh* + PSB (T_7), 50% FYM + 50% VC + Bio-fertilizer (T_8), 50% RDF + 50% FYM (T_9), 50% RDF + 50% VC (T_{10}), 50% RDF + Bio-fertilizers (T_{11}), 50% RDF + 25% FYM + 25% VC + Bio-fertilizer (T_{12}), besides an absolute control *i.e.*, T_1 (no organic, inorganic and bio-fertilizer applied) and was replicated thrice. The climate of the experimental site is temperate characterized by moderately hot summers and very cold winters. Rainfall received during the growing season (April to July) was 113.4 mm. The mean weekly maximum and minimum temperatures during the growing seasons varied from 6.3 to 17.53°C and 18.78 to 32.78°C respectively, whereas mean minimum relative humidity 41.71 to 62.57% and mean maximum relative humidity was 70.57 to 86.86 per cent. Recommended doses of NPK fertilizers (100% as per soil test) applied to French bean were N: P_2O_5: K_2O @ 30:50:30 kg/ha. The 100% NPK was applied as basal at the time of sowing. The recommended dose of *Rhizobium* (20 g/kg seed) or PSB as per treatment was first mixed in clean water to make thick slurry and seed was then inoculated as per treatments with the biofertilizer. Organic manures (farm yard manure and vermicompost) were incorporated according to the treatments at the time of field preparation and mixed thoroughly. French bean (Selection-3) was sown @ 80 kg/ha at 20 × 5 cm spacing on 16th April and harvested on 2th July. All other agronomic practices were followed as per standard recommendations. The grain and straw yield of French bean were recorded and observation on growth and yield attributers were recorded from five randomly selected tagged plants from each plot at 60 days after sowing (DAS). Protein estimation was done in laboratory and protein yield was calculated as per following standard formula

$$\text{Protein yield (kg/ha)} = \frac{\text{Seed yield (kg/ha)} \times \text{Protien content (\%)}}{100}$$

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

Growth Attributes

Results revealed that the various growth parameters (Table-2) increased significantly with the application of various organic and inorganic fertilizers over control except germination percentage. Increasing the inorganic fertilization (RDF) increase growth attributes as compared to growth attributes recorded in control. Application of 125% RDF recorded highest plant height (33.50 cm), primary branches (4.80), secondary branches (4.40), leaf area index (5.77) and total dry weight (22.00 g) and remained statistically at par with the treatment involving substitution of 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}) and were significantly superior over control (T_1) at 60 DAS. While as the minimum plant height (26.05 cm), primary branches (3.07), secondary branches (3.40), leaf area index (0.40) and total dry weight (12.83 g) were recorded in control.

125% RDF (T_4) recorded 45.65%, 71.42%, 37.5%, 318.18% and 46.22% increase in plant height, primary branches, secondary branches, leaf area index and total dry weight, respectively, over control (T_1). Similar findings were also reported by Jagdale *et al.*, (2005). This increase in growth attributes might have been due to more and quick supply of NPK with heavy application of inorganic fertilization which increased photosynthetic activity, cell division, elongation and differentiation etc. resulting in higher growth attributes. The increase in growth attributes at higher fertility levels is in harmony with the findings of Shubashree *et al.*, (2011) and El-Bassiony *et al.*, (2010). Further, increased growth with substitution of 50% RDF by organic manures along with biofertilizers might be due to the fact that organic manures release of nutrients slowly, increases nutrient use efficiency, biological fixation and increased availability of micro-nutrients (Nawalgatti *et al.*, 2009 and Shubasshree *et al.*, 2011).

Yield and Yield Attributes

The data depicted in Table-3 revealed significantly higher yield attributes viz. pods/plant (12.93) at 60 DAS, pods/plant (13.40) at harvest, seeds/pod (5.00), pod length (11.01cm) and 100-seed weight (38.90 g) were recorded with the application of 125% RDF (T_4) without showing any significant difference with the treatment involving application of 50% RDF along with 25% FYM + 25% VC + 20 g biofertilizers/kg seed (T_{12}). The minimum yield attributes viz. pods/plant (6.13) at 60 DAS, pods/plant (7.80) at harvest, seeds/pod (1.90), pod length (5.30 cm) and 100-seed weight (27.27 g) were recorded in control. 125% RDF (T_4) recorded 110.92%, 71.79%, 163.15%, 107.73% and 42.64% pods/plant at 60 DAS, pods/plant at harvest, seeds/pod, pod length and 100-seed weight over control (T_1), respectively. Maximum seed yield (1386.67 kg/ha) was recorded with 125% RDF (T_4) showing 159.19% increase over control while minimum seed yield (535.00 kg/ha) was recorded with control (T_1) where no fertilizer or biofertilizer was applied. However, no statistical difference was found between seed yield (1386.67 kg/ha) with 125% RDF (T_4) and seed yield (1272.00 kg/ha) with 50% RDF + 25% FYM + 25% VC + biofertilizer (T_{12}). Treatments 100% RDF (T_3), 50% RDF +50% VC (T_{10}), 50% RDF + 50% FYM (T_9) and 50% RDF + biofertilizers (T_{11}) were at par with each other. In case of stover yield, maximum stover yield (1249.00 kg/ha) was recorded with 100% RDF (T_3), showing 83.59% increase over control, but remained statistically at par with stover yield (1235.00 kg/ha) with 50% RDF + 25% FYM 25% VC + biofertilizer (T_{12}) and stover yield (1224.00 kg/ha) with 125% RDF (T_4). These results are in line with Abd El-Mawgoud *et al.*, (2005) and Dhanjal *et al.*, (2001).

The increase in yield attributes might have been due to increased availability of NPK, higher total dry matter production and more vegetative growth resulting in better development of yield attributes and higher seed yield with application of heavy inorganic fertilization. Similar results were also reported by Veeresh (2003). Further, higher seed and stover yield by application of inorganic fertilizers in combination with organic manures may be due to its greater availability and uptake of macro and micro nutrients resulting in higher photosynthesis, tissue differentiation and translocation of assimilates etc. leading to higher seed and stover yield (Sen *et al.*, 2002). The data on harvest index indicated that there was no significant difference between the treatments. These results are in agreement with the findings of Thimalia and Abdul Khalak (1993).

The data on seed protein percentage (Table-3) indicated significantly higher protein percentage (21.20 %) with application of 125% RDF (T_4), showings 19.10% increase over control while the minimum protein percentage (17.80%) was recorded with control (T_1). Similar results were also recorded in terms of protein yield, with significantly higher protein yield (294.01 kg ha^{-1}) with application of 125% RDF than all the treatments, showing 19.10 percent increase over control. This might have been due to the increased nitrogen availability and uptake in case of heavy fertilization and nitrogen being an essential component of seed protein. These results are in harmony with Gupta *et al.*, 1996 and Abdel-Mawgoud *et al.*, (2005).

Conclusion

From the study it is concluded that in context of sustainable agriculture, growth, yield and quality may be improved by integrated use of organic and inorganic sources of nutrient under temperate conditions of Kashmir, and the nutrient management of French bean may involve substitution of 50% RDF through 25% FYM (1.5 ton FYM/ha) + 25%VC (0.55 ton VC/ha) + biofertilizer (20 g biofertilizer/kg seed).

Further, the integrated nutrient management is required for sustaining the desired crop productivity by optimizing the benefits from all the sources of plant nutrients in an integrated manner.

Table 1: Various Organic and Inorganic Treatment Combinations

Abbreviation Used	Treatment Details	
T_1	Control	No organic, inorganic or Biofertilizer applied
T_2	75% RDF	22.5 N: 37.5 P_2O_5:22.5 K_2O kg/ha
T_3	100%RDF	30 N: 50 P_2O_5: 30 K_2O kg/ha
T_4	125% RDF	37.5 N: 62.5 P_2O_5: 37.5 K2O kg/ha
T_5	FYM	6 ton/ha
T_6	Vermicompost	2.2 ton/ha
T_7	Biofertilizers (Rhizobia+PSB)	20 g/kg seed
T_8	50% FYM+ 50%VC + Biofertilizers)	3 ton/ha + 1.1 ton/ha + 20 g/kg seed
T_9	50% RDF + 50% FYM	15 N: 25 P_2O_5: 15 K_2O kg/ha + 3 ton/ha
T_{10}	50% RDF + 50% VC	15 N: 25 P_2O_5 :15 K_2O kg/ha + 1.1 kg/ha
T_{11}	50%RDF+Biofertilizer	15 N: 25 P_2O_5:15 K_2O kg/ha + 20 g/kg seed
T_{12}	50%RDF + 25% FYM + 25%VC + Biofertilizer	15 N: 25 P_2O_5: 15 K_2O kg/ha +1.5 ton/ha + 0.55 ton ton/ha + 20 g/kg seed

Table 2: Influence of Organic and Inorganic Fertilizers on Growth Parameters of French Bean (*Phaseolus Vulgaris* L.)

Treatments	Emergence Count	Plant Height (cm)	No. of Primary Branches	No. of Secondary Branches	LAI	Total dry Weight (g)
T_1	81.00	23.00	2.80	3.20	1.21	11.83
T_2	84.00	27.50	3.40	3.60	2.12	18.50
T_3	82.67	32.00	4.40	4.00	5.06	22.00
T_4	85.82	33.50	4.80	4.40	5.77	22.00
T_5	85.55	30.00	3.80	3.80	3.37	20.27
T_6	85.00	30.90	3.80	3.80	3.99	20.40
T_7	88.44	29.30	3.67	3.60	2.77	20.01
T_8	87.50	28.37	3.60	3.60	2.70	19.13
T_9	86.00	31.60	4.00	4.00	4.32	20.60
T_{10}	86.44	31.60	4.40	4.20	4.66	20.70
T_{11}	88.50	31.39	4.20	3.80	4.14	20.60
T_{12}	88.00	32.50	4.60	4.33	5.42	22.00
SEm±	1.88	1.11	0.11	0.11	0.17	0.55
CD ($p \leq 0.05$)	NS	3.28	0.31	0.33	0.50	1.63

Note: 100% RDF =30 N: 50 P_2O_5 :30 K_2O Kg/ha

Table 3: Influence of Organic and Inorganic Fertilizers on Yield Attributes, Yield and Quality of French Bean (*Phaseolus Vulgaris* L.)

Treatments	Pods/plant at 60 DAS	Pods/ Plant at Harvest	Seeds/pod	Pod Length (cm)	100-Seed Weight	Seed Yield (Kg/ha)	Strover Yield (Kg/ha)	Harvest Index (%)	Seed Protein (%)	Protein Yield (kg/ha)
T_1	6.13	7.80	1.90	5.30	27.27	535.00	680.33	44.16	17.80	95.22
T_2	8.20	9.60	2.60	7.07	32.00	890.00	841.33	51.64	18.20	161.98
T_3	11.33	12.60	4.40	9.80	37.00	1190.00	1249.00	48.76	20.80	245.12
T_4	12.93	13.40	5.00	11.01	38.90	1386.67	1224.00	53.06	21.20	294.01
T_5	10.20	10.80	3.20	7.53	34.80	977.00	928.00	51.23	18.46	180.34
T_6	10.13	11.20	3.40	7.80	35.00	1002.00	949.00	51.37	18.48	185.34
T_7	10.13	10.73	3.00	7.33	34.60	952.00	883.67	51.95	18.36	174.79
T_8	8.93	10.40	2.80	7.20	34.30	912.00	920.00	50.01	18.30	166.89
T_9	10.47	11.60	4.00	8.77	36.20	1052.00	985.00	51.72	18.60	195.65
T_{10}	10.80	11.60	3.73	920	36.33	1113.00	1053.33	51.41	18.90	210.41
T_{11}	10.27	11.40	3.60	8.13	35.50	1045.00	973.00	5.90	18.50	193.33
T_{12}	11.67	12.80	4.53	9.93	37.60	1272.00	1235.00	50.74	19.70	250.60
SEm±	0.42	0.55	0.28	0.57	1.28	51.49	32.23	1.61	0.076	10.17
CD ($p \leq 0.05$)	1.25	1.62	0.82	1.69	3.79	152.00	95.15	NS	0.223	29.71

Note: 100% RDF =30 N: 50 P_2O_5 :30 K_2O Kg/ha

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