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Effect of Inorganic, Organic Nutrient Sources and Bio-Fertilizers on Growth Attributes, Biomass at Flowering and Nodule Weight of *Phaseolus vulgaris* (Rajma)

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Abstract

It is essential to adopt new techniques and management practices as integrated nutrient management. The combined use of organic, inorganic manures and bio-fertilizer not only increases the crop yield but also improves the physical, Chemical and biological properties of soil. As enhance these properties, we can enhance the growth rate at flowering and nodule weight of plant, Phaseolus vulgaris. It did positive impact on quality and yield of Rajama. To study this, nine treatments, three replications, RBD design and Dibbling sowing method was adopted. The growth and yield attributes i.e. height, number of branches plant^{-1}, Number of pods plant^{-1}, number of grains pod^{-1} were recorded highest when only inorganic fertilizers @ 150% RDF was applied and these plant characters were recorded lowest when only vermicompost was applied. Biomass production at flowering, grain and straw yield were highest due to application of 150% RDF of NPK through inorganic fertilizers. The lowest biomass production at flowering was recorded where 2.5 t vermicompost at sowing and 50 % N through urea at flowering were applied. The lowest grain yield and straw yield was recorded when only vermicompost @ 5 tonnes ha^{-1} was applied. Fresh weights of nodules were negligible.

Keywords: Phaseolus vulgaris, RBD, NPK

INTRODUCTION:

French bean (*Phaseolus vulgaris* L. Halics) is an important pod vegetable and short duration crop. In Maharashtra, Pune, Satara, Ahemadnagar, Sangli, Nashik and Solapur are the leading district for growing french bean (Sravan ghevda) in *rabi* season. Similarly in Mahabaleshwar and Ratnagiri region, it is grown as a *kharif* crop. It provides direct economic returns in form of pod used as a vegetable and grain for human beings as well as fodder for animals. In India French bean is grown on an area of 42.68 ha and producing 24778 tones with productivity 5-8 t/ha (Anonymous, 2003).

Atmospheric Nitrogen fixation is a unique feature of leguminous crops, but French bean is an exception with a little or no Nitrogen fixation. This is because of the absence of NOD gene regulator (Pathak and Khurana, 1993). Being nodulation legume, it requires fairly large quantity of nitrogenous fertilizer (Sharma, *et al*., 1976; Shrinivas Rao, 1984). It is almost unable to fix atmospheric nitrogen symbiotically, hence responds well to Nitrogen application (Khushwant, 1994). French bean productivity is low in Maharashtra. Inadequate use of fertilizers is one of the most important reasons of its low productivity under situation of Marathwada, where the black soils (Vertisols) are deficient in both nitrogen and phosphorus. Potassium is sufficient in these soils. Therefore, nitrogen and phosphorus are considered to be necessary in increasing grain yield and quality of French bean. Nitrogen is necessary for development of vegetative and reproductive plant parts. It increases earliness of crop height number of pods, yield. Phosphorus is essential for the energy transformation. It is also integral part of genetic material both DNA and RNA. During seed formation and development phosphorus

is translocated from vegetative parts to seeds and thus is considered essential for seed formation (Tisdale and Nelson, 1985). Therefore phosphorus requirement of French bean also stand to be quite higher, hence it becomes a need of the day to formulate the package of these limiting nutrients.
Looking to economical condition of farmer and cost of fertilizers, it is essential to adopt new techniques and management practices as integrated nutrient management. Thus it gives present scenario to study, "Effect of Inorganic, Organic Nutrient Sources and Bio-Fertilizers on Growth Attributes, Biomass at Flowering and Nodule Weight of of *Phaseolus vulgaris* (Rajma)".

MATERIALS AND METHODS:

A field experiment was carried out to study "Integrated nutrient management for Rajma (French bean). The nutrient sources were organic manures, inorganic fertilizers, micronutrients and bio-fertilizers. Effect was studied on yield and uptake of nutrients by French bean". The experiment was conducted in *Rabi* season of 2005-2006 at experiment farm of Department of Agricultural Chemistry and Soil Science, College of Agriculture, Parbhani (MS) India. An information regarding the kind of soil, treatment details, design of experiment and number of replications, methods for analysis of quality parameters, crop growth studies, the source of nutrients and statistical analysis are presented. The procedures followed for sampling of soil as well as for plant along with the methods of analysis are also presented here under with suitable sub titles.

Experimental design and treatments:

The field experiment was conducted in *rabi* 2005-2006 with nine treatments and three replications in Randomized Block Design. The recommended dose of fertilizer for rajma was 120:60:60 kg NPK ha^{-1}. The treatments in which micronutrients are included, they were applied as 25 kg $ZnSO_4$ and 25 kg $FeSO_4$ per hectare. In treatments where nutrients were applied through organic manures, vermicompost was applied before sowing @ 2.5 or 5.0 t ha^{-1}. The treatments where biofertilizers are included *Rhizobium* and phosphote solubilizing bacteria 250 g each were inoculated per 100 kg of rajma seed. Seed was coated with *Rhizobium phaseoli* and phosphate solubilizing bacteria *Pseudomonas striata* before sowing.

Nutrient sources:

(1). Inorganic fertilizer: through urea (46%0, through single super phosphate, through murate of photas (60% K_20).
(2) Micro-nutrient: through $ZnSO_4$, through $FeSO_4$.
(3). Organic fertilizers: Vermicomost applied as par tretement.
(4).Bio-fertilizers: a). *Rhizobium phaseoli* b) phosphate solubilizing bactria- *Psedomonas striata*
Details of field Experiments:

1.	Number of treatments	09
2.	Number of replications	03
3.	Design of experiment	RBD
4.	Gross plot size	4.5m X 3.6 m
5.	Net plot size	3.3 X 3.0m
6.	Spacing (row to row and plant to plant)	30cm X 15cm
7.	Total No. of plots	27.
8.	Method of sowing	Dibbling
9.	Variety of crop	Araka komal

Treatment details:

Symbols	Treatment
T_1	Recommended dose of fertilizer (RDF) i.e. 120:60:60 kg NPK/ha.
T_2	RDF + Rhizobium (*Rhizobium* strain for Rajma will be used i.e. *Rhizobium phaseoli* + PSB (Phosphate solubalizing bacteria).
T_3	RDF + Zn (through 25 kg $ZnSO_4$) + Fe (through 25 kg $FeSO_4$) + *Rhizobium* + PSB
T_4	150% RDF i.e. 180:90:90 NPK kg ha^{-1} + Zn + Fe + *Rhizobium* + PSB
T_5	2.5 t ha^{-1} vermicompost + 50% N through urea at sowing time.
T_6	2.5 t ha^{-1} vermicompost + 50% N through urea + Zn + Fe at sowing + Rhizobium + PSB.

T_7	2.5 t ha^{-1} vermicompost at sowing + 50% N through urea at flowering stage.
T_8	As per soil test NPK application at sowing.
T_9	Vermicompost 5 t ha^{-1} at sowing + *Rhizobium* + PSB

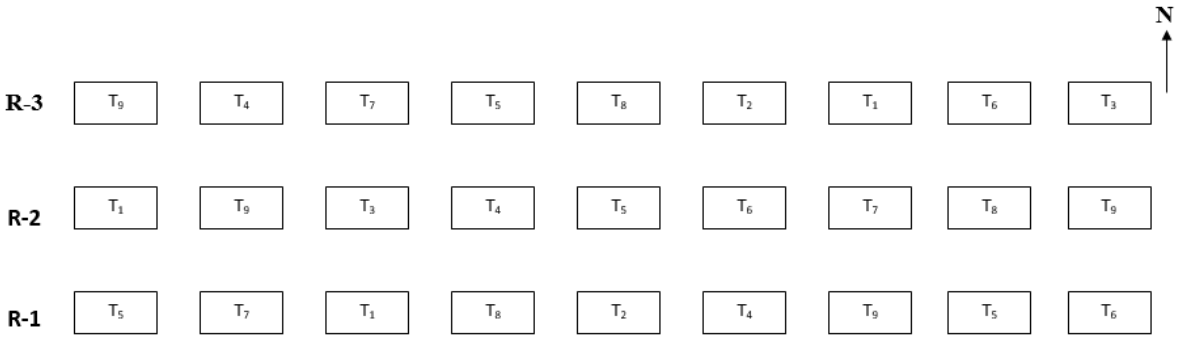

Fig. 1 Layout of Field Experiment

Growth observations:

Biomass at flowering (35 days): Five plants from each plot were selected randomly. The plants were uprooted, cleaned and dried in shade. After oven drying at 70°C the dry matter weight was taken and recorded as biomass weight. Further these weights were converted after calculation as biomass weight per hectare.

Plant height: Five plants were selected randomly from each plot. The plant height was measured from above ground (surface of soil) to top of the plant with the help of meter scale and calculated mean value. This observation was taken 35 days after sowing.

Number of branches: From above randomly selected plants numbers of branches per plant at 35 days after sowing were counted and mean values are given.

Number of pods per plant: Number of pods per plant on above randomly selected plants was counted from each plot. The mean values are computed.

Number of grains per pod: Numbers of grains per pod above randomly selected were recorded at harvest of crop. Five plants were used for number of pods per plant and mean values are given.

Harvesting and threshing: The crop was harvested on dated 5.2.2006 at maturity when leaves had started to turn yellow and pods were also turned to yellow. The plants from the plots were harvested air dried and threshed. Grain and straw samples for further studies were collected plot wise and properly labeled. Grain and straw weight were recorded and further calculated as quintal per hectare.

OBSERVATIONS, RESULT, DISCUSSIONS AND CONCLUSION:

Observations:

Plate 1: General View of Experimental plot of *Phaseolus vulgaris* (Rajma)

Plate 3: Treatment without *Rhizobium* PSB

Plate 2: Treatment with *Rhizobium* PSB

RESULT AND DISCUSSION

from the observations results were shown in below Tables**:**

Table 1 Effect of inorganic organic nutrient sources and Bio-fertilizers on growth attributes of *Phaseolus vulgaris* (Rajma)

Treatments	Height (cm)		No. of branches/plant		No. of pods/plant	No. of Grains/pods
	35 days	At harvest	35 days	At harvest		
T_1	45.8	46.1	5.2	5.8	9.18	6.1
T_2	46.00	46.7	5.4	6.1	10.02	6.4
T_3	46.2	47.0	5.4	6.0	10.07	6.5
T_4	47.9	48.4	6.0	6.4	10.78	7.2
T_5	36.4	37.1	5.1	5.5	7.30	6.2
T_6	45.6	46.2	5.8	6.3	8.82	6.8
T_7	44.5	45.8	4.1	5.0	8.00	6.5
T_8	44.9	45.5	5.6	5.9	9.60	6.7
T_9	35.7	36.3	5.0	5.2	7.20	5.8
S.E. +	1.13	1.12	0.09	0.09	0.08	0.012
CD at 5%	3.39	3.36	0.27	0.28	0.25	0.36

Table 2 Effect of Inorganic, Organics nutrient sources and Bio-fertilizers on biomass at flowering (q ha^{-1}) and fresh nodule weight (g) of *Phaseolus vulgaris* (Rajma)

Treatments	Biomass at flowering (q ha^{-1})	Fresh nodule weight (g)
T_1	4.313	Negligible
T_2	4.638	Negligible
T_3	4.666	Negligible
T_4	5.450	Negligible
T_5	4.313	Negligible
T_6	4.235	Negligible

T_7	3.669	Negligible
T_8	4.538	Negligible
T_9	3.958	Negligible
S.E. +	0.145	-
CD at 5%	0.437	-

A] Effect of inorganic, organic nutrient sources, bio-fertilizers alone and their combination on growth attributes of *Phaseolus vulgaris* (Rajma)

- **Effect on plant height (cm):** The data indicated taller plant of rajma when NPK was applied to soil through inorganic fertilizers (**Table 1**). High dose of NPK (180:90:90 kg ha^{-1} i.e. 150% RDF) recorded highest plant height i.e. 47.9 cm at 35 days after sowing and 48.4 cm at harvest of rajma followed by T_3>T_8>T_2 and T_1. The treatments where 2.5 t of vermicompost and 50% N through urea, either at sowing or at flowering with or without micronutrients and bio-fertilizers recorded comparatively lesser plant height as compared to 100% RDF. The lowest plant height at flowering and at harvest i.e. (35.7 cm) and (36.3 cm) was observed in T_9 treatment where only 5 t vermicompost ha^{-1} was applied. The results also indicated that there was no significant increase in plant height, when bio-fertilizers or micronutrients were applied. Application of N (50% of RDF) applied at sowing or at flowering had no significant increase in plant height at 35 days after sowing but slightly increased in T_7 at harvest as compared to other treatments.
- **Effect on number of branches/plant:**The results from **Table 1** indicated that highest number of branches/plant both at 35 days after sowing and at harvest of rajma were observed when NPK was applied to soil through inorganic fertilizers. Higher dose of NPK (180:90:90) recorded highest number of branches $plant^{-1}$ (i.e. 5.8 at 35 DAS and 6.4 at harvest) followed by T_6, T_8, T_3, T_2 and T_1. The treatments where 2.5 t of vermicompost and 50% N through urea either at sowing or at flowering with or without micronutrients and biofertilizers recorded comparatively lesser number of branches $plant^{-1}$ as compared to 100% RDF. The lowest numbers of branches plant-1 were observed in T_9 treatment. The results also indicated that there was no significant increase in number of branches $plant^{-1}$, when bio-fertilizers or micronutrients and 50% N of RDF were applied.
- **Number of pods per plant:** The data **(Table1)** indicated that there was significant effect of the different treatments on number of pods per plant. Maximum number of pods per plant (10.78) were in T_4 which followed by T3, T_2, T_8 and T_1. Numbers of pods per plant were found statistically at par due to treatments receiving 2.5 t vermicompost + 50% N. (T_5) and (T_9). The results also showed that there was no significant increase in number of pods per plant when biofertilizers or micronutrients
- **Number of grains per pod**: From the (**Table 1)** indicated that the maximum number of grains per pod i.e. 7.2 were observed in treatment T4 which received 180:90:90 NPK/ha i.e. 150% RDF application through inorganic fertilizers. The lowest number of grains per pod i.e. (5.8) was observed in T_9 which received 5 t vermicompost ha^{-1}. Number of grains per pod were found statistically at par with treatments receiving 100% RDF as inorganic source and 2.5 t vermicompost + 50% N through inorganic source i.e. urea in T_7 and T_8 as per soil test values application through inorganic sources. The results also indicated that there was no significant increase in number of grains per pod due to application of biofertilizers or micronutrients. 50% N through urea applied at sowing or flowering had no significant effect.

B] Effect of Inorganic, Organics nutrient sources and Bio-fertilizers on biomass at flowering (q ha^{-1}) and fresh nodule weight (g) of *Phaseolus vulgaris* (Rajma)

- **Effect on biomass at flowering:** The data regarding biomass production at flowering as influenced by different treatments are presented in **Table 2.** The higher yield of biomass production was recorded. When NPK was applied to soil through inorganic fertilizers i.e (T_1, T_2, T_3, T_4 and T_8) treatments. High dose of NPK: (180:90:90 kg ha^{-1} i.e. 150% RDF) application through inorganic fertilizers recorded 5.45 kg ha^{-1} biomass which was highest among all treatments it was followed by T_3, T_2, T_8 and T_1 treatments. The treatments where 2.5 t of vermicompost ha^{-1} and 50% N of RDF through applied at sowing with or without micronutrients and biofertilizers recorded comparatively lesser biomass production at flowering as compared to 100% RDF. The lowest biomass production (3.69 kg ha^{-1}) at flowering was observed in T_7 treatment where 2.5 t vermicompost ha^{-1} was applied and 50% N. The results also showed that difference in biomass production due to T_9 treatment i.e. 5 t vermicompost and T_7 treatments i.e. (3.985 q ha^{-1} and 3.66 q ha^{-1}) were statistically at par. The data (**Table 2**) indicated that there was no significant increase in biomass at flowering due to application of biofertilizers or micronutrients.
- **Effect on fresh nodule weight:** At the time of flowering, plants from each treatment were uprooted carefully, so that root system of plant was not disturbed. These plants were washed with water gently. Then observations on all root nodules were taken with open eyes but not a single root nodule was observed. No,

native Rhizobium, inoculation is not effective; no optimum number of cells or seed is not achieved high number of *Actinomycetes*.

Effect of inorganic and organic nutrient sources with bio-fertilizers on growth of Rajma: The growth attributes of Rajma as plant height (35 DAS and at harvest), number of branches per plant number of pods plant^{-1}, number of grains pod^{-1} of rajma were studied and the results presented in Table 1 are discussed below. The data indicated that the growth attributes were significantly increased due to application of 150% RDF of NPK ha^{-1} through inorganic fertilizers. The increase in growth attributes may be due to supply of nutrients in sufficient quantities Rajpal *et al.* (2003) reported increased growth attributes due to adequate availability of nutrients. There might have been taken up by plants for greater photosynthesis, which ultimately increased plant growth parameters. Patel *et al.* (1994) reported that all growth attributes were increased with increasing levels of N and P, which could be ascribed to the overall improvement in plant growth and vigour as it plays an important role in plant metabolism Kumar and Rao (1991) reported that 100% RDF of NPK application increased the growth attributes due to greater nutrient availability and increase in photosynthetic rate. Kumar *et al.* (2004) reported that all growth attributes were significantly increased by application of inorganic nutrient sources i.e. 120N: 60 P_2O_5 : 45 K_2O kg ha^{-1} in French bean.

The increases in growth attributes due to adequate supply of nutrients from other treatments were vermicompost biofertilizers used. Subba Rao (1986) studied effect of application of PSB and *Rhizobium* and observed increased growth attributes due to increased solubilization of phosphorus by producing organic acids and growth promoting substances. Sarkar *et al.* (1993) showed that increase in growth due to N and P in combination with *Rhizobium* might be due to synergistic effect of *Rhizobium* inoculation. Dash *et al.* (2005) studied that application of crop residue 5t ha^{-1} + FYM 5t ha^{-1} + Zn 5kg ha^{-1} increased all growth attributes. It might be due to greater availability of macro-micronutrients from organic sources which helped in acceleration of various metabolic processes.

Similar observations were found by Rana and Singh (1998). Tiwari and Singh (2000), Sharma (2001), Vishwkarma *et al.* (2002), Rana *et al.* (2003), Lal (2004), Deshmukh *et al.* (2005). Lowest growth attributes were observed in T_9 treatment where only 5t vermicompost ha^{-1} with biofertilizers was applied. Sonboir and Sarwai (2000) reported that lowest growth attributes were due to lack of initial inorganic nitrogen and potassium. Sarkar *et al.* (1993) reported that absence of N and P through inorganic nutrient sources resulted in reduction in vegetative growth of plants.

Effect on biomass at flowering: The data regarding biomass production at flowering as influenced by different treatments are presented in Table 1. High dose of NPK (180:90:90 kg ha^{-1} i.e. 150% RDF) application through inorganic fertilizers recorded 15.45 q ha^{-1}) biomass which was highest among all treatments. Similar observations were recorded by Babhulkar *et al.* (2000). They observed increased biomass production due to addition of inorganic fertilizers which resulted of the improvement in root and shoot growth. Sonboir and Sarawal *et al.* (2000) noted that application of 60 kg P_2O_5 ha^{-1} along with PSB + *Rhizobium* and micronutrients helped in accumulation of biomass due to various metabolic processes. Rajpal *et al.* (2003) reported that there was increase in biomass production due to increasing level of P. Kumar *et al.* (2004) reported that application of nutrients 120:60:45 kg NPK ha^{-1} through inorganic sources significantly increased the biomass production. It might be due to excessive vegetative growth of the crop. Further they also reported that increase in biomass production with N P in combination with *Rhizobium* might be due to synergistic effect.

Lower biomass production (3.66 q/ha) was observed, where 2.5 t vermicompost at sowing and 50% N through urea at flowering was applied. Similar results were also found by Sonboir and Surawai (2000). They reported lowest biomass production when N was applied at flowering. It might be due to lack of initial nitrogen supply. Santhy *et al.* (1999) noted lower biomass production as a result of higher stress due to inadequate nutrient supply and restricted crop production and reduction in biomass.

Conclusion:

The growth and yield attributes i.e. height, number of branches plant^{-1}, Number of pods plant^{-1}, number of grains pod^{-1} were recorded highest when only inorganic fertilizers @ 150% RDF was applied and these plant characters were recorded lowest when only vermicompost was applied. Biomass production at flowering, grain and straw yield were highest due to application of 150% RDF of NPK through inorganic fertilizers. The lowest biomass production at flowering was recorded where 2.5 t vermicompost at sowing and 50 % N through

urea at flowering were applied. The lowest grain yield and straw yield was recorded when only vermicompost @ 5 tonnes ha^{-1} was applied. Fresh weights of nodules were negligible.

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