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Consequence of Inorganic, Organic Nutrient Sources and Bio-Fertilizers on Percentage Uptake of Major Nutrients (N, P, and K) in Grains, Straw and Total of *Phaseolus vulgaris* (Rajma)

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ABSTRACT
The French bean is an important source of protein for world-wielding countries. Rajma is quite nutritious containing 20.69 to 25.81 percent crude protein 1.72 percent fat and 72.42 percent carbohydrates. Besides this 5.89 mg of iron 20.02 to 9.62 mg of methionine per 100 gm of protein 381 mg of calcium, and 425 mg phosphorus per 100 gm of edible parts. Looking towards the economic condition of farmers and the cost of fertilizers, it is essential to adopt new techniques and management practices such as integrated nutrient management. In present research was carried out to study the 'effect of the combination of different fertilizers on nutrient uptake by Rajma. In this study, Inorganic fertilizers, Micro-nutrients, Organic fertilizers, and Bio-fertilizers were used as integrated parts. Here, "Effect of Inorganic, Organics Nutrient sources, and Bio-fertilizers on Percentage Concentration and Uptake of Major nutrients N, P, and K of Grain, straw and total in kg ha^{-1} by Phaseolus vulgaris (Rajma)" was done". The statistical design was adopted to obtain relevant and useful information for Randomized Block Design. The statistical analysis of the data was done by the standard statistical methods of analysis of variance. Results tabulated and recorded. The importance of N concentration (%) and uptake (kg ha^{-1}), P concentration (%) and uptake (kg ha^{-1}), and K concentration (%) and uptake (kg ha^{-1}) were studied. It was shown that Integrated strategies enhance the uptakes of nutrients.
Keywords: *Phaseolus vulgaris (Rajma), Major Nutrients N, P, and K, RBD, etc.*

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INTRODUCTION

Phaseolus vulgaris (L. Halics), French Bean is an important pod vegetable and short-duration crop. It belongs to the family Leguminaceae. It is popularly known as field bean, green bean, kidney bean, dry bean, common bean, garden bean, snap bean, etc. French is an important source of dietic protein for world-wielding countries. Rajma is quite nutritious containing 20.69 to 25.81 percent crude protein 1.72 percent fat and 72.42 percent carbohydrates. Besides this 5.89 mg of iron 20.02 to 9.62 mg of methionine per 100 gm of protein 381 mg of calcium, and 425 mg phosphorus per 100 gm of edible parts. Ali and Khushwanta (19.87) reported that Rajama contains 3.84 mg zinc per 10 gm. Looking towards the economic condition of farmers and the cost of fertilizers, it is essential to adopt new techniques and management practices such as integrated nutrient management. The combined use of organic and inorganic manures not only increases the crop yield but also improves the physical and biological properties of soil. The use of organic manures with an optimum rate of fertilizers under an intensive farming system increased the turnover of nutrients in the soil plant system [1]. Organic manures such as FYM and vermicompost are not just sources of nutrients but also have profound effects on physical properties resulting in a better soil structure, greater water retention in soil, and more favorable environment for root growth and better infiltration of water. FYM contains 0.5 percent N, 0.2 percent P_2O_5, and 0.5 percent K_2O [2]. Vermicompost application to the soil drastically improves soil fertility, improves pH, increases water holding capacity, and enhances

infiltration, enhancing its exportability [3]. It contains 1.60 percent N, 2.20 percent P_2O_5, and 0.65 percent K_2O [4]. The application of inorganic fertilizers along with biofertilizers gives better results. The application of Rhizobium for nitrogen fixation and phosphate solubilizing bacteria (PSB) for phosphorus availability is most advantageous. The number of pods and seed yield plant^{-1} and seeds per pod were noticed to be increased with Rhizobium inoculation [5]. Inoculation of Rhizobium phaseoli reduced the accumulation of nitrate Sulphur in shoots, fruit and roots of plants. PSB possesses the ability to bring phosphorus in soil to soluble forms by secreting glycolic, fumaric and succinic acids and phytase enzymes. Thus, it increases the phosphorus availability of crops. The inoculation of phosphate-solubilizing bacteria increased yield and phosphorus uptake. The organic fertilizers along with biofertilizers help in reducing the dose of inorganic fertilizers, which in turn reduces the cost of cultivation and helps in improving the soil health, therefore, the present investigation was taken as "Integrated Nutrient Management" with organic manure and inorganic fertilizers and biofertilizers on yield and uptake of nutrients by French bean with the objectives as, 'To study the effect of the combination of different sources of fertilizers on nutrient uptake by Rajma'.

MATERIAL AND METHODS

A field experiment was conducted to study "Integrated nutrient management for Rajma (French beans). The nutrient sources were organic manures, inorganic fertilizers, micronutrients, and biofertilizers. The effect was studied on yield and uptake of nutrients by French bean". The experiment was conducted in the Rabi season at an experiment farm of the Department of Agricultural Chemistry and Soil Science, College of Agriculture, Parbhani (MS) India. Information regarding the kind of soil, treatment details, design of experiment and number of replications, methods for the 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 plants along with the methods of analysis are also presented here under suitable sub-titles. Parbhani district covers 61308 sq km geographical area which is centrally situated in the Marathwada region of Maharashtra state. The area belongs to the Godavari peninsular basin situated on the northern side of the district. Geographically, Parbhani district is situated within the Godavari drainage basin in the central part of India between 76^{o}46'E longitude and 19^{o}46'N latitude, having an elevation of 408.46 m above the mean sea level. The Parbhani district falls under a semi-arid tropical climate in the Deccan plateau. The average rainfall of the district is 830 mm, mostly concentrated during monsoon, particularly from June to October. Maximum rainfall occurs in the month of July and August. The annual maximum temperature ranges from 29.1^{o}C to 41.1^{o}C and minimum from 12.1^{o}C to 24.5^{o}C in May and December, respectively. The mean minimum and maximum relative humidity varied between 25 to 63 and 85 to 96 percent, respectively. Physico-chemical properties of soil were studied before the experimental conductions. The field experiment was conducted in Rabi with nine treatments and three replications in Randomised Block Design. The recommended dose of fertilizer for Rajma was 120:60:60 kg NPK ha^{-1}. The treatments in which micronutrients are included 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 phosphate solubilizing bacteria 250 g each were inoculated per 100 kg of rajma seed. The 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 mutate of photos (60% K_20).

(2) Micro-nutrient: through $ZnSO_4$, through $FeSO_4$.

(3). Organic fertilizers: Vermicompost applied as par treatment.

(4). Bio-fertilizers: a). Rhizobium phaseoli b) phosphate solubilizing Bactria- *Pseudomonas striata*

Field Experiment Details:

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

Details of Treatment :

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 solubilizing 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

A}. Analysis methods for Nutrients:

Available Nitrogen: The alkaline permanganate method was adopted for estimating the available nitrogen from soil [8].

Available phosphorus: It was determined by Olsen's method using 0.5 m sodium bicarbonate ($NaHCO_3$) as an extract. Darco G 60 free from phosphorus was used to absorb the dispersed organic matter and to make filtrate clear for further colorimetric estimation [9].

Available potassium: 25 ml neutral normal ammonium acetate solution was used to extract the 5 gm of soil and then filtered through Whatman No.1 filter paper to determine the 'K' content of the filtrate on the flame photometer by maintaining air pressure of flame photometer [10].

B}. Grain and Straw Analysis: For the determination of nutrient contents that are N, P, K, Fe, and Zn in plant samples were taken at harvest separating pod and roots. First of all the plants were washed with tap water and the roots were discarded; the plants were further rinsed in a detergent solution followed by distilled water. After cleaning, plants were dried in the shade and subsequently in the oven at 70°C. The oven-dried samples were ground in an electrically operated grinder with stainless steel blades up to maximum fineness. The powdered samples were stored in polythene pockets with proper labeling and these were further used for nutrient analysis in straw. Grains were taken separately for grain analysis.

Digestion of grain and straw for P and K. -One gram of finely powdered plant, straw, or grain sample was taken in a 100 ml conical flask. 5 ml of concentrated nitric acid was added to it and kept overnight. On the next day, 10ml of diacid mixture (HNO_3 and $HClO_4$ in 9:4) was added and digested on a hot plate as described by Piper [18]. After digestion known volume of extract was prepared with glass distilled water and filtered. The same extract was used for the estimation of P, K, Fe, and Zn.

Nitrogen: The plant and grain nitrogen content was determined by Microkjeldhal's method as described in A.O.A.C. [1].

Phosphorus: The plant and grain phosphorus were determined by the Vanadophosphomolybdate yellow color method as given by Piper [18].

Potassium: Plants $grain^{-1}$ potassium content was determined from the diacid extract on a flame photometer [11].

Uptake of Nutrients: Uptake of nutrients i.e. N, P, and K were computed considering biological yield (i.e. grain and straw) and concentration of the particular nutrient.

$$\text{Uptake nutrient (Kg. ha}^{-1}\text{)} = \frac{\text{Nutrient Content Concentrations \% X Yield of grains straw}^{-1}\text{ (Kg ha-1)}}{100}$$

The statistical analysis of the data was done by the standard statistical methods of analysis of variance [17]. The appropriate standard error (SE $\pm$ (m) for each factor was worked out. The results were tested for their

significance by F values. To compare two treatments means the critical difference (C.D.) at a 5% level of significance was worked out and is given wherever needed.

RESULTS AND DISCUSSIONS

Results are tabulated from observations shown in the Tables and Figures given below,

Table 1: % Concentration of Major Nutrients -N, P, and K of Grain, Straw, and Total in *Phaseolus vulgaris* (Rajma)

Treatments	N concentration (%)			P concentration (%)			K concentration (%)		
	Grain	Straw	Total	Grain	Straw	Total	Grain	Straw	Total
T_1	3.45	1.56	2.31	0.39	0.35	0.36	1.15	0.58	0.80
T_2	3.66	1.58	2.39	0.46	0.37	0.40	1.16	0.60	0.81
T_3	3.82	1.70	2.47	0.49	0.39	0.43	1.21	0.65	0.87
T_4	3.92	1.89	2.68	0.52	0.40	0.44	1.22	0.70	0.98
T_5	3.29	1.47	2.14	0.32	0.29	0.30	1.03	0.51	0.64
T_6	3.40	1.49	2.23	0.36	0.33	0.34	1.08	0.54	0.73
T_7	3.36	1.56	2.23	0.35	0.30	0.31	1.03	0.51	0.64
T_8	3.57	1.79	2.52	0.42	0.36	0.38	1.18	0.68	0.88
T_9	3.15	1.40	2.06	0.35	0.32	0.33	1.05	0.46	0.58
S.E. ±	0.338	0.206	0.005	0.065	0.042	0.012	0.108	0.099	0.006
C.D. at 5%	NS	NS	0.017	NS	NS	NS	NS	NS	0.019

Table -2: Effect of Inorganic, organic nutrient sources, and Bio-fertilizers on Uptake of Major nutrients N, P, and K of Grain, straw, and total in kg ha^{-1} by *Phaseolus vulgaris* (Rajma)

Treatments	N uptake (kg ha^{-1})			P uptake (kg ha^{-1})			K uptake (kg ha^{-1})		
	Grain	Straw	Total	Grain	Straw	Total	Grain	Straw	Total
T_1	37.75	25.45	63.2	4.25	5.69	9.94	12.57	9.49	22.51
T_2	41.83	27.81	69.64	5.24	6.60	11.84	13.31	40.53	23.84
T_3	45.96	31.06	77.02	6.02	7.25	13.27	14.96	11.89	26.85
T_4	53.94	41.28	95.22	7.16	8.94	16.1	17.66	15.61	33.27
T_5	29.89	23.25	53.14	2.60	4.21	6.81	9.38	6.56	15.94
T_6	35.75	23.97	59.72	3.45	5.42	8.87	11.37	8.36	19.73
T_7	33.65	24.14	57.79	3.53	4.62	8.15	10.35	6.17	16.52
T_8	40.58	29.48	70.06	4.77	5.89	10.66	13.32	11.19	24.51
T_9	25.84	22.69	48.53	2.07	3.67	2.74	7.76	5.90	13.66
S.E. ±	1.176	1.221	0.037	0.214	0.140	0.086	0.500	0.552	0.006
C.D. at 5%	3.520	3.656	0.011	0.642	0.420	0.259	1.498	1.653	0.020

A field experiment was conducted in Rabi Season on an experimental farm of the Department of Agriculture Chemistry and Soil Science, College of Agriculture, Parbhani. The field experiment was carried out to study, "Integrated Nutrient Management *Phaseolus vulgaris* (Rajma) ". Nutrient sources were inorganic fertilizers (NPK and micronutrients), Organic manure, and bio-fertilizers. The effect of these nutrient sources alone and in combination was studied on nutrient availability at harvest in soil and other physio-chemical properties of soil, growth attributes, yield, and uptake of nutrients, and quality parameters of rajma. The results are presented under suitable headings.

Effect of Inorganic, Organic Nutrient Sources and Bio-fertilizers on Uptake of Major Nutrients N, P, and K of Grain, straw, and Total in kg ha^{-1} by *Phaseolus vulgaris* (Rajma)

After harvest the crop weight of dried plants was recorded. These were thrashed and the weight of grain and straw were recorded treatment wise. Total plants excluding roots, grains, and straw were collected separately. These were grained and were analyzed in a laboratory for N, P, and K concentrations from these concentrations' treatment uptake was calculated and was presented as kg ha^{-1}.

Nitrogen concentration (%) and uptake (kg ha^{-1}): The analytical data on N concentration (%) in total plant, grain, and straw are given in Table 1. Results indicated that N concentration was higher in grain followed by total plant and than in straw. N concentration in grain ranged from 3.15% (T_9) to 3.92% (T_4). It was observed that N concentration in grain was on the higher side when N was applied to soil through inorganic fertilizers. The N concentration was medium 50% N was given through inorganic fertilizers with 2.5 t vermicompost ha^{-1}. It was also seen that where N through inorganic fertilizers was not applied to soil had the lowest (3.15%) N in the grains among all treatments.

Similar behavior due to different treatments concerning percent N concentration in plants and Straw was observed. However, the differences in percent N concentration in total plant as well as in Grain and Straw due to different nutrient sources were nonsignificant. The results on N uptake kg ha^{-1} by total plant grain and straw are given in Table 2. The treatment differences are statistically significant. The results indicated that N uptake kg ha-1 was highest i.e. 53.94 kg ha^{-1} due to application of 150% RDF through inorganic fertilizers. The uptake was followed by other treatments, where N through only inorganic fertilizers at the rate of 100% RDF was applied. When N through only 5 t vermicompost ha^{-1} was supplied showed the lowest i.e. 25.8 kg ha^{-1} N uptake. Similar results were observed in N uptake by straw as well as by total plant.

Phosphorus concentration (%) and uptake (kg ha^{-1}): The analytical data on P concentration (%) in the total plant, grain, and straw are given in Table 1. The result indicated that P concentration (%) was higher in grain followed by total plant and straw. P concentration in grain ranged from 0.35% (T_9) to 0.52% (T_4). P concentration in grain was on the higher side when P was applied to soil through inorganic fertilizers. The treatment where P was not applied through inorganic fertilizer grain had the lowest 0.52% P as compared to other treatments.

Similar behavior by different treatments concerning P concentration (%) in plants and straw was observed. However, the differences in P concentration (%) in total plant as well as in grain and straw due to different nutrient sources were non-significant. The results on P uptake kg ha^{-1} by total plant, grain, and straw are given in Table 2. The treatment differences are statistically significant. The results indicated that P uptake kg ha^{-1} was highest i.e.7.16 kg ha^{-1} due to the application of 150% RDF through inorganic fertilizers. The uptake was followed by other treatments where P was applied inorganic fertilizers at the rate of 100% RDF, 5 t vermicompost ha^{-1}. Application of micronutrients as well as biofertilizers had significant improvement in P uptake. Similar results were observed in P uptake in straw as well as by plant.

Potassium concentration (%) and uptake (kg ha^{-1}): The analytical data on K concentration (%) in total plants, grain, and straw are given in Table 1. The results indicated that K concentration was high in grain followed by total plant and then straw. K concentration in grain ranged from 1.05% to 1.22% (in T_9 and T_4 treatments). K concentration in grain was to be on the higher side when K was applied in the soil through inorganic fertilizers. The treatment where K through inorganic fertilizers was not applied to soil had the lowest i.e. 1.05% K among all treatments in grain.

A similar effect of different treatments for K concentration in plants and in straw was also observed. However, the differences in K concentration (%) in the total plant as well as in grain and straw due to different nutrient sources, were nonsignificant.

The results on K uptake kg ha^{-1} by total, plant, grain, and straw are given in Table 2. The results indicated that K uptake kg ha^{-1} was highest i.e. 17.66 kg ha^{-1} due to application of 150% RDF through inorganic fertilizers. The uptake was followed by other treatments where inorganic fertilizers at the rate of 100% RDF were applied. When K through only 5 t vermicompost/ha was supplied caused the lowest i.e.7.76 kg ha^{-1} K uptake. Similar results were observed in K uptake in straw.

DISCUSSION

N concentration (%) and uptake (kg ha^{-1}): The analytical data on N concentration (%) and uptake (kg ha^{-1}) in the total plant, grain, and straw given in Table 1 and 2, indicated that higher N concentration and uptake (2.68%), (95.22 kg total) was recorded in T_4 treatment where 150% RDF of NPK was applied. Similar observations were found by Hadwani and Gundalia [9]. They reported that the application of the NPK combination had a synergetic effect of NPK interaction on the total uptake of N which was obvious and directly related to the increasing N concentration in the plant. It might be attributed to enhancing vigor of

crop growth and increase in N utilization and translocation into the plant. Subba Rao (1986) recorded the highest N content and uptake due to 100% RDF + Rhizobium + PSB. He explained this might be due to readily available N through chemical fertilizers and atmospheric N fixed by Rhizobium which was accumulated in plants. Similar results were also found by Hasanabade [10], Deshmukh et al. [5], and Kamble and Mohite [12].

The lowest N concentration and total uptake (1.40 % and 95.22 kg ha^{-1}) were recorded where only 5 tonnes of vermicompost was applied. It may be due to less content and supply of nitrogen.

P concentration (%) and uptake (kg ha^{-1}): The analytical data on P concentration and uptake by the total plant, grain, and straw yield given in Table 1 and 2 indicated that higher P concentration and uptake by plant grain and straw was observed in T_4 treatment where 150% RDF of NPK kg/ha with micronutrient and biofertilizers were applied. The higher concentration of P and uptake of P in plants may be due to the availability of P through chemical fertilizers and the ability of PSB to transform insoluble P in soil into soluble forms by secreting organic acids resulting in effective solubilization and utilization of P. Similar observations were found by Hadwani and Gundalia [9]. They found a synergetic effect of NPK interaction on the uptake of P which was directly related to the increase in P concentration in plants. Nikanja et al. (1996) observed that the P content (%) and uptake (kg ha^{-1}) was highest with 60 kg P_2O_5 ha^{-1}. The lowest P concentration % and uptake by plant grain and straw were recorded where only 5 tonnes of vermicompost was applied. The lowest P concentration and uptake due to the application of organic source alone may be due to lesser content and supply of similar results was also recorded by Guge [8].

K concentration (%) and uptake (kg ha^{-1}): The analytical data on K concentration (%) and uptake (kg ha^{-1}) in the total plant, grain, and straw are given in Table 1 and 2 indicated that higher K concentration and uptake 2.08% and 33.27 kg ha^{-1} was recorded in T_4 treatment where 150% RDF of NPK were applied. This may be due to adequate content and supply of available K by the fertilizers. Similar observations were found by Hadwani and Gundalia [9]. They found that due to the application of NPK in combination, a synergetic effect of NPK interaction was observed on the total uptake of K. Mathan et al. [15] noted that the application of Inorganic combined with organics increased uptake of K due to more availability of nutrients from added fertilizers coupled and more solubility of K through inorganic acids produced during the mineralization of farmyard manure. Similar observations were also recorded by Hasnabade [10], Deshmukh et al. ([6]. The lowest concentration (%) and uptake (kg ha^{-1}) i.e. 0.58%, and 13.66 kg ha^{-1} respectively were recorded when 5 tonnes of vermicompost was applied.

CONCLUSION

Integrated applications of the organics nutrient sources, and bio-fertilizers on percentage concentration and uptake of major nutrients N, P, and K of Grain, straw, and total in kg ha^{-1} by *Phaseolus vulgaris* (Rajma) were carried out. The importance of N concentration (%) and uptake (kg ha^{-1}), P concentration (%) and uptake (kg ha^{-1}), and K concentration (%) and uptake (kg ha^{-1}) were studied and results were recorded. It was shown that Integrated strategies enhance the uptakes of nutrients.

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CONSENT FOR PUBLICATION

Not Applicable

COMPETING INTEREST

The author declares that they do not have any competing interests.

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