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Bio-chemical changes in Indian bean (*Lablab purpureus* L. var. *typicus*) under application of nitrogen, phosphorus and bio-fertilizers

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Abstract
An experiment was carried out during the *kharif* season on loamy sand soil to study on the biochemical changes in pods of Indian bean under the application of different recommended doses of NP and bio-fertilizers. The application of 75 per cent Recommended Dose of NP and combined inoculation with *Rhizobium* + VAM + PSB significantly increased the crude protein content, nitrogen and phosphorus content and reduced crude fibre content in pods of Indian bean cv. Arka vijay. The combined application of 75% RD of NP and *Rhizobium* + VAM + PSB was proved superior for biochemical improvement in pods of Indian bean.

Keywords: Indian bean, nitrogen, Rhizobium, PSB, VAM, protein, crude fibre

Introduction
Indian bean is also known as Dolichos bean (*Lablab purpureus* L. var. *typicus*) which belongs to the family Fabaceae having chromosome number 2n = 22. This is grown for its immature, tender and green pods to consume as vegetable although, its dry seeds are also used in various vegetable food preparations as well as for animal feed. Indian beans are an excellent source of minerals specially copper, zinc, calcium, iron, magnesium, potassium, phosphorus and manganese. As per nutritional composition its edible green pod contains 86% moisture, 2.0% crude fibre, 4.0% crude protein, 1.0% fat, 7.10% carbohydrate, 48 Kcal energy, 210 mg calcium, 68 mg phosphorus, 1.0 mg iron, 668 IU vitamin A, 0.08 mg thiamine, 0.11 mg riboflavin, 0.75 mg niacin and 9.3 mg vitamin C (Gopalan *et al*., 2004) [2].
Being a leguminous crop Indian bean is highly responsive to application of nitrogenous fertilizer especially in early stage however, good amount of phosphorus also required for its optimum growth and yield. Due to huge hike in the prices of chemical fertilizers, to maintain the ecosystem of soil and improve the biochemicals of produce, combined use of inorganic and biofertilizers of microbial origin is needed. Application of biofertilizers like PSB and VAM and *Rhizobium* inoculation for legumes crops, increases microbial population in the rhizosphere, which not only improve the amount of microbiologically fixed nitrogen but also increase absorption of unavailable phosphorus for the plant growth (Kristek *et al*., 2005) [5]. Use of biofertilizers might have improved nodulation, crop growth, nutrient uptake, crop yield and quality of produce in legume crops (Shrivastava and Ahlawat, 1995) [10].
The objective of this study was to evaluate the appropriate fertility level along with suitable biofertilizer for better improvement in biochemical contents of Indian bean pod.

Materials and Methods
An experiment was conducted at Horticulture farm, S.K.N. College of Agriculture, Jobner, Jaipur during *kharif* season for better improvement in biochemical contents in Indian bean cv. Arka vijay under application of biofertilizers with graded doses of nitrogen and phosphorus. The experiment was laid out in split plot design having 20 treatments with four replications. The treatments included four levels of recommended dose of nitrogen and phosphorus (0, 50% RDF, 75% RDF, 100% RDF ha^{-1}) in main plots and five levels of inoculation with bio-fertilizers (control, PSB, VAM, *Rhizobium* and PSB + VAM + *Rhizobium*) in sub plots. Observations on changes in nitrogen content (%), phosphorus content (%), crude protein (%) and crude fibre content (%) in pods were recorded.

Results and Discussion

The increasing levels of N and P significantly improved N and P concentration in green pods of Indian bean (Table -1). this might be due to improved nutritional environment in the rhizosphere as well as in the plant system leading to enhanced translocation of N and P in plant parts. The no-inoculation treatment (control) had a significant difference in nitrogen and phosphorus content as well as protein content of pods in comparison to inoculated one. However, PSB + VAM + *Rhizobium* in combination significantly increased the nitrogen and phosphorus concentration in green pod and protein content in green pod over control and PSB and VAM alone. Thus, inoculation with PSB + VAM + *Rhizobium* proved superior to other treatments. The increase in these values due to inoculation of seed with *Rhizobium* was probably due to more fixation of nitrogen resulting into better utilization of nutrients by plants, which led to more chlorophyll formation and ultimately nitrogen and phosphorus concentration in green pod and protein content in pods. Significant increase in nitrogen and phosphorus concentration of green pod was also observed with PSB and VAM. PSB and VAM enhanced the availability of phosphorus to plants, which might have utilized by the crop in greater root development and nodulation that in turn resulted in higher nitrogen fixation in the soil by nodules. Thus, increased availability of nitrogen and phosphorus might have resulted in greater uptake by the plants for proper development and ultimately increased their content in plants. VAM increased nutrient uptake through reduction of the distance that nutrient must diffuse to plant roots by accelerating the rate of nutrient absorbing surface (Bowen *et al*. 1975) [1] and finally by chemically modifying the availability of nutrient for uptake by plant through *mycorrhizal hyphae* (Somani, 2004) [12].

The combined inoculation with PSB + VAM + *Rhizobium* was more beneficial in enhancing all the above parameters due to increased solubility of phosphorus and higher nitrogen fixation in nodules, leading to increased availability of nitrogen and phosphorus. These results are in accordance to the findings of Tanwar *et al.* (2003) [13], Jain and Trivedi (2005) [3], Vikram and Hamzehzarghani (2008) [15] and Netwal *et al*. (2018) [8].

Table 1: Effect of fertility levels and bio-fertilizers on nitrogen and phosphorus content (%) in pods of Indian bean.

Treatments	Nitrogen content (%)	Phosphorus content (%)
Fertility levels		
F_0 (0% RD of NP)	0.453	0.417
F_1 (50% RD of NP)	0.508	0.447
F_2 (75% RD of NP)	0.573	0.493
F_3 (100% RD of NP)	0.576	0.510
S.Em +	0.012	0.007
CD (P=0.05)	0.037	0.024
Bio-fertilizers		
B_0 (No biofert.)	0.482	0.454
B_1 (PSB)	0.526	0.465
B_2 (VAM)	0.528	0.469
B_3 (Rhizobium)	0.543	0.460
B_4 (PSB+VAM+Rhizobium)	0.559	0.486
S.Em +	0.010	0.007
CD (P=0.05)	0.030	0.021

Application of 75% RD of NP (22.5 kg N and 37.50 kg P_2O_5/ha) significantly improved protein content from 2.91 per cent in control to 3.51 per cent (Fig. 1) and reduced crude fibre content (Fig. 2). It might be due to increase in N concentration in green pod which might be the result of increased availability of nitrogen to plants. Another reason for higher nitrogen concentration might be due to increased activity of nitrate reductase enzyme. Higher nitrogen in green pod is directly responsible for higher protein because it is a primary component of amino acids which constitute the basis of protein. These results are in close conformity with the findings of Kasturi Krishna and Ahlawat (2000) [4], Singh *et al*. (2006) [11], Pandya and Bhatt (2007) [9], Kumawat *et al.* (2014) [6] and Maya Yadav *et al*. (2017) [7].

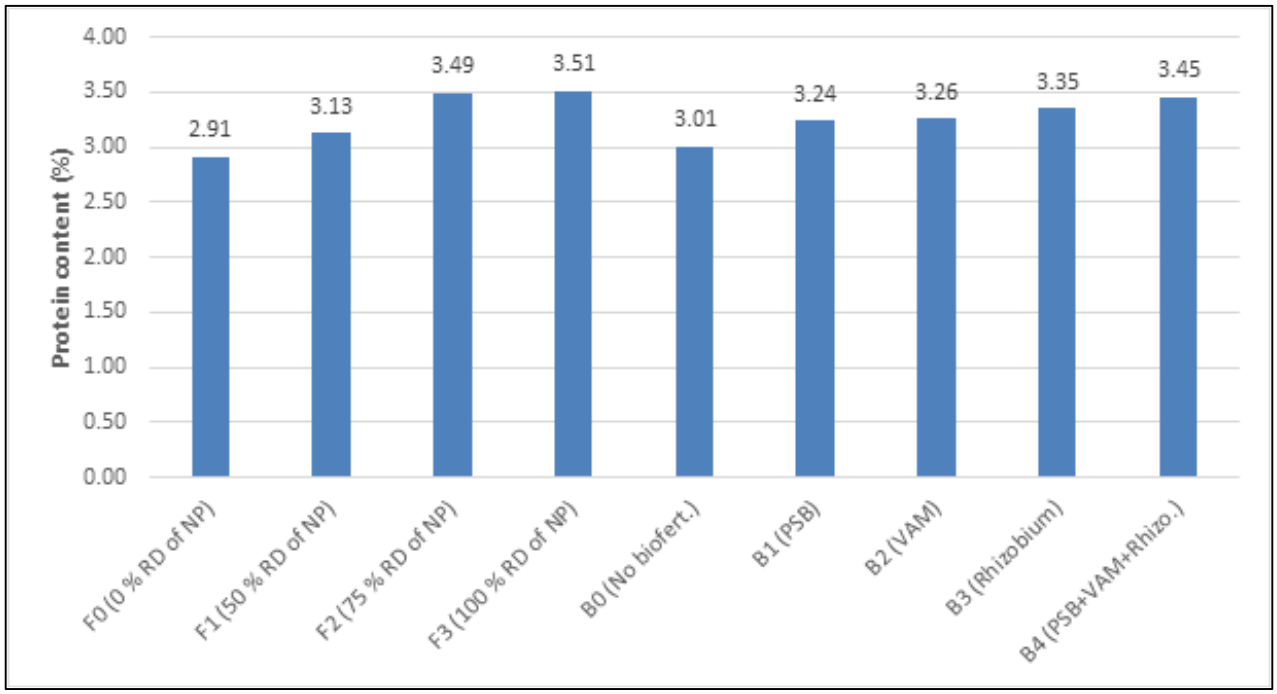

Fig 1: Effect of fertility levels and bio-fertilizers on protein content (%) in pod of Indian bean

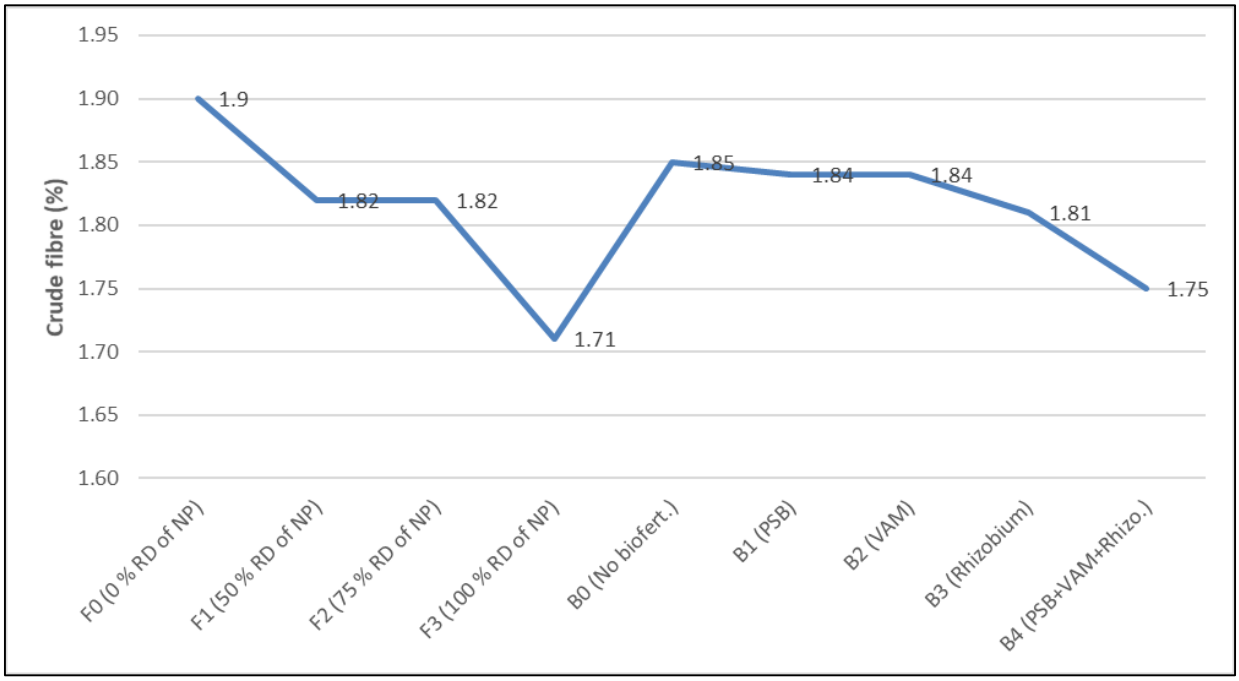

Fig 2: Effect of fertility levels and bio-fertilizers on crude fibre (%) in pod of Indian bean

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