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Effect of organic, inorganic fertilizer and foliar spray on quality, nutrient content, uptake and soil status of Indian bean (*Lablab purpureus* L.)

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Abstract
A field experiment was carried out during *rabi* season of 2015-16 on vertisols of Navsari, Gujarat to study the "Nutrient management in Indian bean (*Lablab purpureus* L.) Under south Gujarat condition". The soil of experimental field was clayey in texture, low in available nitrogen (197.26 kg/ha), medium in available phosphorus (30.93 kg/ha) and fairly rich in available potassium (369.80 kg/ha). Total twelve treatment combinations consisting of two levels of inorganic fertilizer *viz*., F1 (100% RDF) and F2 (125% RDF), three types of organic manure *viz*., O1 (2 t/ha FYM), O2 (2 t/ha Biocompost) and O3 (2 t/ha Vermicompost) and two levels of foliar spray *viz*., S1 (Without spray) and S2 (1% Banana pseudostem enrich sap spray at 30 and 60 DAS) were evaluated in randomized block design with factorial concept with three replications. The result showed that quality parameters like protein content (20.35%) and protein yield (149.06 kg/ha) as well as N, P and K content and uptake by seed, stover and their total and availability of N, P_2O_5 and K_2O in the soil after harvest of Indian bean were also recorded significantly higher with application of 125% RDF through inorganic fertilizer (F2) over 100% RDF (F1). The treatment O2 (2 t/ha biocompost) resulted in significantly higher protein content and protein yield (20.93% and 153.15 kg/ha, respectively). Almost similar trend was also found for N, P and K_2O content and their uptake by seed and stover as well as available N, P_2O_5 and K_2O status of soil after harvest of crop. Significantly higher content and uptake of N, P and K by seed and stover and their total as well as available N, P_2O_5 and K_2O status of soil after harvest of crop were also recorded under foliar application of 1% banana pseudostem enrich sap over control.

Keywords: Indian bean, nutrient management, biocompost, foliar spray, protein content, protein yield, nutrient content, nutrient uptake, soil status

1. Introduction
The Indian bean, scientifically known as *Lablab purpureus* L., is an exceptional legume with a rich history deeply intertwined with the cultural and agricultural heritage of India and other parts of the world. It is grown throughout tropical regions of Asia, Africa and America. In India, it is grown as a field crop in Tamil Nadu, Andhra Pradesh, Karnataka, Madhya Pradesh and Maharashtra. This resilient and versatile crop has been a source of sustenance, nutrition, and ecological benefits for centuries. In recent years, its significance has gained prominence in the context of sustainable agriculture and food security due to its remarkable adaptability to diverse agro-climatic conditions, as well as its multifaceted contributions to both farming systems and human nutrition. A new variety GNIB -21 found most promising for vegetable purpose due to it's short stature plants, early picking and short maturity. It became popular among the farmer of south Gujarat due to it's suitability as intercrop also. Now days, use of chemical fertilizer is increasing to boost up crop production. Simultaneously, cost of chemical fertilizer is increased constantly, besides these, only use of inorganic fertilizer is injurious to soil health and soil productivity. Integration of inorganic, organic and bio-fertilizer play vital role for enhancing crop productivity and sustaining soil fertility, this proves great promise for farmer. Thus, the basic concept underlying the principles of integrated nutrient management is the maintenance and possible improvement in soil fertility for sustained crop productivity on long term basis (Harisudan *et al*., 2009) [5]. Foliar application of fertilizers for increasing and exploiting genetic potential of the crop is considered as an efficient and economic method of supplementing the nutrient requirement. Application of inorganic spray will also enhances play a pivotal role in increasing the seed yield in pulses (Chandrasekhar and Bangarusamy, 2003) [2]. Foliar application of major nutrients like NPK was found to be more advantageous than soil application and also avoiding the depletion of these nutrients in leaves, thereby

resulting in to an increased photosynthetic rate, better nutrients translocation is credited with the advantage of quick and efficient utilization of nutrients, elimination of losses through leaching and fixation and helps in regulating the uptake of nutrients by plants (Manomani and Srimathi, 2009) [6]. A judicious combination of chemical fertilizer and organic fertilizer should be formulated for Indian bean variety GNIB-21 under south Gujarat condition; hence, the present study is proposed.

2. Materials and Methods

An experiment was conducted on plot no. D-17 at College Farm, N.M. College of Agriculture, Navsari Agricultural University, Navsari, during *rabi* season of 2015-16. Geographically, the Navsari Agricultural University is situated at 20° 57' N latitude and 72° 54' E longitude, 10 metres above mean sea level. Navsari is situated in the heavy rainfall zone-I of south Gujarat (Agro-ecological situation-III). The weather in this region is typically subtropical, with a humid and warm monsoon that brings heavy rainfall, a somewhat cold winter, and a moderately hot summer. This tract receives 1440 millimetres of rain on average each year. The experimental field's soil had a clayey texture, moderate to poor drainage, an EC of 0.36 dS/m, and a pH of 7.80. The soil has a medium level of organic carbon (0.53%), low levels of nitrogen and phosphorus (both 30.93 kg/ha) and potassium (369.80 kg/ha) that are readily available. Total twelve treatment combinations consisting of two levels of inorganic fertilizer *viz*., F1: 100% RDF and F2: 125% RDF, three types of organic manure *viz*., O1: 2 t/ha FYM, O2: 2 t/ha Biocompost and O3: 2 t/ha Vermicompost and two levels of foliar spray *viz*., S1: Without spray and S2: 1% Banana pseudostem enrich sap spray at 30 and 60 DAS were evaluated in randomized block design with factorial concept with three replications. A test crop of the Indian bean variety GNIB 21 was planted at a 45 cm × 20 cm interval. An experimental plot was manure as per treatment with inorganic fertilizer and organic manure before sowing of crop. Required quantity of FYM, biocompost and vermicompost as well as inorganic fertilizer in the form of urea and DAP (Diammonium phosphate) were calculated and manually applied in opened furrows as per treatment before sowing. Gap filling and thinning were done when necessary and harvesting was done when the crop was fully developed. According to the recommendations for this region's good agricultural growth, irrigation, plant protection, and other practices were employed. The economics of each treatment were calculated based on the input and output market prices in Indian rupees at that point in time. The various procedures performed as well as the resources utilised for crop raising were employed to compute the entire cost of agriculture. The experimental design and treatment means were statistically analysed using the usual analysis of variance technique, and the t-test and CD value were used to compare the means at the P = 0.05 level of probability.

3. Results and Discussion

3.1 Protein content (%) and protein yield

3.1.1 Effect of inorganic fertilizer

The variation in protein content in seed and protein yield of Indian bean was found significant due to application of different levels of inorganic fertilizer. Application of 125% RDF (F2) resulted in significantly higher protein content (20.35%) in seed and Protein yield (149.06 kg/ha) over 100% RDF (F1) (Table 1). The probable reason of increase in protein content in seed because of timely availability of adequate amount of nutrients to plant which resulted in higher supply of N throughout the crop growth period resulted in higher protein content in seed. Further higher seed yield in this treatment (F2) with higher protein content ultimately resulted in higher protein yield. These results are in agreement with those reported by Mere *et al*. (2013) [7] in soybean and Zahida *et al.* (2016) [15] in French bean.

3.1.2 Effect of organic manures

The effect of various organic manures on protein content in seed was found significant (Table 1). The highest protein content (20.93%) and protein yield (153.15 kg/ha) in seed of Indian bean was obtained with application of 2 t/ha biocompost (O_2) over other treatments. Whereas, the lowest protein content (18.34) and protein yield (118.78 kg/ha) in seed of Indian bean was noted under application of 2 t/ha FYM over other treatments. The probable reason of increase in protein content in seed because of favourable effect of biocompost on microbial activity as well as higher content of nutrients resulted in higher supply of N throughout the crop growth period resulted in higher N content in seed (Table 1). Higher protein yield was resultant effect of higher protein content and higher yield in this treatment i.e O_2. Similar findings were also reported by Choudhary *et al.* (2016) [3] and Patel *et al.* (2016) [8] in greengram.

3.1.3 Effect of foliar spray

The results furnished in Table 1 indicated that protein content in seed was influenced significantly by foliar sprays. The highest protein content in seed (20.37%) and protein yield (147.67 kg/ha) was recorded with foliar application of 1% banana pseudostem enrich sap (S2) compared to control (S1). The probable reason of increased in protein content in seed might be favourable effect of foliar spray of banana pseudostem enrich sap on plant. It makes easy availability of adequate nutrients to plant at most critical growth stage resulted in higher uptake of N lead to higher protein content in seed. Further higher protein content and higher seed yield ultimately resulted in higher protein yield. Similar findings were also reported by Patil and Gunjal (2011) [11] in green gram, Patil *et al*. (2012) [12] in chickpea and Singhal *et al.* (2015) [14] in cowpea.

3.2 Nutrient content and uptake

3.2.1 Effect of inorganic fertilizer

The results showed in Table 1 indicated that Significantly higher nitrogen (3.25%), phosphorus (0.85%) and potassium (1.13%) content in seed were recorded with Experimental results 88 application of 125% RDF (F2) through inorganic fertilizer than 100% RDF (F1) to Indian bean. Application of 125% RDF (F2) resulted in significantly higher N (0.99%), P (1.04%) and K (2.09%) content in stover than 100% RDF (F1).

3.2.2 Effect of organic fertilizer

The nitrogen, phosphorus and potassium content in seed were increased significantly with application of 2 t/ha biocompost (O2) over other treatments. Whereas, the minimum nitrogen, phosphorus and potassium content in seed were recorded under treatment O1 (2 t/ha FYM) than other treatments. The

nitrogen, phosphorus and potassium content (0.99%, 1.05% and 2.10%, respectively) in stover were found significantly higher with treatment O2 (2 t/ha biocompost) than other treatments, but in case of nitrogen content in stover it was remained at par with treatment O3 (2 t/ha vermicompost) (Table 1).

3.2.3 Effect of foliar spray

Foliar application of 1% banana pseudostem enrich sap (S2) resulted in significantly higher nitrogen, phosphorus and potassium content (3.25%, 0.84% and 1.11%, respectively) in seed over control (S1). Foliar application of 1% banana pseudostem enrich sap (S2) was resulted in significantly higher nitrogen, phosphorus and potassium content (0.99%, 1.04% and 2.09%, respectively) in stover as compared to without spray (S1) (Table 1).

3.3 N, P and K content and uptake

3.3.1 Effect of inorganic fertilizer

Various levels of inorganic fertilizer had significant effect on N, P and K content and uptake in seed and stover (Table 1 and Table 2). Nitrogen, phosphorus and potassium content and uptake in seed and stover were recorded significantly higher with application of 125% RDF (F2) over 100% RDF (F1). This might be due to higher dose of fertilizer increased the availability of nutrients to crop. Similarly, uptake of these nutrients by seed and stover of Indian bean as well as its total were also differed significantly due to various levels of inorganic fertilizer (Table 1). Significantly higher uptake of N, P and K by seed, stover and its total were recorded with application of 125% RDF (F2) over 100% RDF (F1). The increase in uptake of nutrients by seed and stover of Indian bean as well as its total might be attributed to irrespective of increased in concentration of nutrients and yield. These results are in closed conformity with the finding of Dekhane *et al*. (2011) [4] in cowpea and Singh and Kumar (2016) in cluster bean.

3.3.2 Effect of organic fertilizer

Effect on nutrients content and uptake Organic manures had significant effect on N, P and K content in seed and stover ((Table 1). Nitrogen, phosphorus and potassium content in seed and stover were remarkably increased with the application of 2 t/ha biocompost (O2) over other treatments. But, it was remained at par with treatment O3 (2 t/ha vermicompost) for nitrogen content in stover. Improvement in chemical properties of soil as well addition of high amount of nutrients through incorporation of biocompost resulted in increasing the availability of nutrients. Uptake of these nutrients by seed and stover of Indian bean as well their total were also significantly differed due to application of organic manures (Table 2). Significantly higher uptake of N, P_2O_5 and K_2O by seed and stover as well as their total were registered with application of 2 t/ha biocompost (O2) over other treatments. But, it remained statistically at par to treatment O3 (2 t/ha vermicompost) for uptake of P_2O_5 by seed and uptake of N by stover. The increased in uptake of nutrients by seed and stover of Indian bean might be attributed to irrespective of increased in concentration of nutrients and yield. These results are in close vicinity with the findings of Singh and Prasad (2008) [13] in chick pea, Patel *et al*. (2016) [8] and Sindhi *et al.* (2016) [11] in greengram.

3.2.3 Effect of foliar spray

Foliar spray of organic had significant effect on N, P and K content in seed and stover of Indian bean (Table 1). Foliar application of 1% banana pseudostem enrich sap (S2) resulted in significantly higher nitrogen (3.25%), phosphorus (0.84%) and potassium content (1.11%) content in seed over without spray (S1). Almost similar trend was also observed for nitrogen, phosphorus and potassium content in stover of Indian bean due to foliar application of 1% banana pseudostem enrich sap (S2). The probable reason for increased in N, P and K in seed and stover might be due to favourable effect of organic spray which supplies nutrients at right time with easy availability of nutrients facilitate the plant for more absorbtion of nutrients. Uptake of these nutrients (N, P and K) by seed, stover and its total were also differed significantly due to application of treatments of foliar spray. Significantly higher uptake of N, P and K by seed and stover as well asits total were noted with foliar application of 1% banana pseudostem enrich sap (S2) over without spray (Table 2). The increased in uptake of nutrients by seed, stover and its total might be attributed to irrespective of increased in concentration of nutrient and yield. These results are in close vicinity with the findings of Patil and Gunjal (2011) [11], Anathi and Vanagamudi (2014) [1] in green gram, Patil *et al.* (2012) [10] in chickpea and Singhal *et al.* (2015) [14] in cowpea.

3.4 Effect of treatments on nutrient status of soil after harvest of crop

3.4.1 Effect of inorganic fertilizer

Data presented in Table 2 clearly indicated application of 125% RDF (F2) resulted in significantly higher available N (253.25 kg/ha), available P_2O_5 (43.20 kg/ha) and available K_2O (307.91 kg/ha) in soil after harvest of crop over application of 100% RDF (F1).

3.4.2 Effect of organic fertilizer

The application of different organic manures showed significant influence on available nutrient status in soil after harvest of Indian bean (Table 2). Available nitrogen status of soil (256.20 kg/ha) was noted significantly higher under treatment O2 (2 t/ha biocompost) being at par with treatment O3 (2 t/ha vermicompost) than treatment O1 (2 t/ha FYM). While available P_2O_5 (44.54 kg/ha) and K_2O (309.67 kg/ha) were recorded significantly higher with treatment O3 (2 t/ha vermicompost), but it remained statistically on same bar with treatment O2 (2 t/ha biocompost) over treatment O1 (2 t/ha FYM).

3.4.3 Effect of foliar spray

Data presented in Table 2 recorded that foliar spray of organic manifested their significant variance for available N, P_2O_5 and K_2O status of soil. Foliar application of 1% banana pseudostem enrich sap (S_2) resulted in significantly higher available N (256.69 kg/ha), P_2O_5 (43.87 kg/ha) and K_2O (310.91 kg/ha) in soil after harvest of crop as compared to control (S1). It might be due to that foliar application of organic at right time and inadequate quantity fulfil the nutrients requirement of crop which reduced the absorption of nutrients from soil may lead to reserve the Discussion 120 native nutrients in soil. Similar results were also reported by Singhal *et al.* (2015) [14] in cowpea.

Table 1: Protein content, protein yield, nitrogen, phosphorus, potassium content in seed and stover of Indian bean as influenced by various treatments

Treatments	Protein content (%)	Protein yield (kg/ha)	N content (%)		P content (%)		K content (%)	
			Seed	Stover	Seed	Stover	Seed	Stover
Inorganic fertilizer (F)								
F_1 - 100% RDF	19.02	124.40	3.04	0.94	0.75	0.96	1.03	2.00
F_2 - 125% RDF	20.35	149.06	3.25	0.99	0.85	1.04	1.13	2.09
S.Em.±	0.26	3.78	0.04	0.01	0.01	0.01	0.01	0.02
C.D. (P=0.05)	0.76	11.09	0.12	0.03	0.03	0.03	0.03	0.06
Organic manures (O)								
O_1 - 2 t/ha FYM	18.34	118.78	2.93	0.91	0.74	0.96	1.04	2.03
O_2 - 2 t/ha Biocompost	20.93	153.15	3.34	0.99	0.85	1.05	1.13	2.10
O_3 - 2 t/ha Vermicompost	19.79	138.26	3.16	0.97	0.80	0.99	1.06	2.00
S.Em.±	0.32	4.63	0.05	0.01	0.01	0.01	0.01	0.03
C.D. (P=0.05)	0.93	13.58	0.15	0.04	0.03	0.04	0.04	0.08
Foliar spray (S)								
S_1 - Without spray	19.00	125.80	3.04	0.93	0.76	0.95	1.05	2.00
S_2 - 1% Banana pseudostem enrich sap spray	20.37	147.67	3.25	0.99	0.84	1.04	1.11	2.09
S.Em.±	0.26	3.64	0.04	0.01	0.01	0.01	0.01	0.02
C.D. (P=0.05)	0.76	11.09	0.12	0.03	0.03	0.03	0.03	0.06
Interaction	NS	NS	NS	NS	NS	NS	NS	NS

Table 2: Uptake of nitrogen, phosphorus and potassium by seed, stover, total uptake, Available N, P $_2O_5$ and K_2O status of soil after harvest of Indian bean as influenced by various treatments

Treatments	N uptake (kg/ha)			P uptake (kg/ha)			K uptake (kg/ha)			Available N (kg/ha)	Available P_2O_5 (kg/ha)	Available K_2O (kg/ha)
	Seed	Stover	Total	Seed	Stover	Total	Seed	Stover	Total			
Inorganic fertilizer (F)												
F_1 - 100% RDF	19.90	12.54	32.22	4.97	12.63	17.60	6.71	26.18	32.89	241.58	40.47	297.97
F_2 - 125% RDF	23.85	14.78	38.64	6.25	15.46	21.71	8.24	31.09	39.33	253.25	43.20	307.91
S.Em.±	0.61	0.34	0.90	0.17	0.34	0.48	0.20	0.74	0.89	3.38	0.68	3.11
C.D. (P=0.05)	1.77	1.00	2.64	0.50	0.99	1.42	0.60	2.16	2.16	9.93	1.99	9.13
Organic manures (O)												
O_1 - 2 t/ha FYM	19.00	12.21	31.20	5.00	12.34	17.34	6.75	26.14	32.89	236.20	38.60	293.38
O_2 - 2 t/ha Biocompost	24.50	14.82	39.32	6.19	15.74	21.93	8.24	31.49	39.74	256.20	42.36	305.79
O_3 - 2 t/ha Vermicompost	22.12	13.64	35.73	5.64	14.04	19.67	7.42	28.29	35.71	249.83	44.54	309.67
S.Em.±	0.74	0.42	1.10	0.21	0.41	0.59	0.25	0.90	1.09	4.15	0.83	3.81
C.D. (P=0.05)	2.17	1.23	3.23	0.61	1.21	1.74	0.73	2.65	3.19	12.16	2.44	11.18
Foliar spray (S)												
S_1 - Without spray	20.13	12.54	32.67	5.07	12.77	17.84	6.92	26.70	33.61	238.13	39.80	294.97
S_2 - 1% Banana pseudostem enrich sap spray	23.63	14.57	38.19	6.15	15.32	21.47	8.03	30.59	38.62	256.69	43.87	310.91
S.Em.±	0.61	0.34	0.90	0.17	0.34	0.48	0.20	0.74	0.89	3.39	0.68	3.11
C.D. (P=0.05)	1.77	1.00	2.64	0.50	0.99	1.42	0.60	2.16	2.16	9.93	1.99	9.13
Interaction	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Initial soil status	-	-	-	-	-	-	-	-	-	5.81	6.88	4.36

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