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# Standardisation of optimum requirement of nitrogen, phosphorus and potassium on growth parameters of pole bean (*Phaseolus vulgaris* L.)

**Jyothi BS, Narasegowda NC and Manukinda Adinarayana**

## Abstract
Field investigation on "Standardisation of optimum requirement of nitrogen, phosphorus and potassium for pole bean (*Phaseolus vulgaris* L.)" was carried out at the Department of Horticulture, Gandhi Krishi Vignana Kendra, University of Agricultural Sciences, Bangalore during *kharif* 2014-2015. The experiment consisting of 18 treatment combinations with three levels each of nitrogen (63, 75 and 90 kg N $ha^{-1}$) and phosphorus (100, 125 and 150 kg $P_2O_5$ $ha^{-1}$) and two levels of potassium (75 and 90 kg $K_2O$ $ha^{-1}$) with 3 replications was laid out in Factorial Randomized Complete Block Design. Significantly maximum number of branches (7.61) and leaves (167.19) per plant, total fresh (0.97 kg) and dry weight (201.68 g) per plant, leaf area per plant (16313.67 $cm^2$), leaf area index (4.53) and chlorophyll reading (54.39) were observed in the treatment which received 75 kg N $ha^{-1}$. Interaction effect between $N_2P_2$ (75 kg N and 125 kg $P_2O_5$) produced higher number of leaves and branches per plant ( 185.16 and 8.42), leaf area (17193.48 $cm^2$) and leaf area index per plant (4.776), SPAD meter reading (56.11) and total fresh weight per plant (1.06 kg and 0.47 kg) at 60 and 100 DAS, respectively. The same interaction combination recorded significantly higher dry weight per plant (221.89 g and 89.93 g) at 60 and 100 DAS, respectively. From this investigation it can be concluded that significant results were noticed in pole bean with respect to growth parameters when the crop is supplied with increased levels of nitrogen and phosphorous nutrients.

**Keywords:** Nitrogen, Phosphorous, Potassium, SPAD

## Introduction
Pole bean (*Phaseolus vulgaris* L.) is a spreading type of French bean and is a newly introduced crop to eastern dry zone of Karnataka (Zone-5). The area under this crop is gradually increasing due to its high yield and good returns. It belongs to the family Fabaceae. It is also called as snap bean, kidney bean and navy bean. It is an important warm season crop grown both for tender pods and dry seeds.

Pole bean being native to South and Central America probably Mexico, is being widely cultivated in tropical, sub-tropical and temperate regions. Its cultivation in India is mainly confined to northern hilly tracts of Jammu and Kashmir, Himachal Pradesh and Uttar Pradesh as a *kharif* crop and in some parts of Maharashtra, Andhra Pradesh, Western and Eastern ghats and North eastern plain zone. It is cultivated even during *rabi* season, where winters are mild and frost free.

Pole bean grows to a height of 1.52- 3.04 mts, it needs support of trellis (or) other structure with simple cultivation practices. Its yield is two to three times more than bush beans in a period of 100 days. Although both types have similar requirements, pole beans need a 1.52-2.43 mts tall support that can provide strong background. They are grown commercially in the mountain countries and on a limited scale, in a few of the eastern countries. Pole beans are grown for their distinctive flavour, long pods, high yield, long harvesting season and high returns.

Pole beans play a key role in crop rotation and intercropping systems (Lambrecht *et al.*, 2013). Pole type cultivars were developed with the purpose of adding more value in yield potentials and improve yield steadiness as compared with bush varieties (Nienhuis and Singh, 1988).

Pole bean being a shy nodulation legume requires fairly large quantity of nitrogenous fertilizer (Sharma, *et al.*, 1996). It is almost unable to fix atmospheric nitrogen symbiotically, hence responds well to N application. Nitrogen is a major constituent of chlorophyll, the most vital pigment needed for photosynthesis and amino acids synthesis. (Hortensteiner and Feller, 2002). It requires more nitrogen and phosphorus for root development, nodulation and better plant growth and hence, responds even to application of phosphorus fertilizer (Ssali and Keya, 1986).

Potassium has an important role in regulating the water loss of plant, thus, help to prevent plant from necrosis (Broun *et al.*, 2006). It serves as an activator of enzymes used in photosynthesis and respiration, helps to build cellulose which aids in photosynthesis by the formation of a chlorophyll precursors and finally results in quality pods (Pretorius, 2009).

Since pole bean is a newly introduced crop, the work on standardization of agro-techniques in general and nutrition requirement in particular is very meagre. In the absence of information of nutrition requirement for pole bean, recommended dose of fertilizers for bush type of French bean is being followed. Hence, this study will be helpful for ascertaining the precise dosage of fertilizers requirement for better growth and yield of pole bean.

## Material and Methods

The present investigation "Standardisation of optimum requirement of nitrogen, phosphorus and potassium for pole bean (*Phaseolus vulgaris* L.)." was carried out at the Department of Horticulture, Gandhi Krishi Vignana Kendra, University of Agricultural Sciences, Bengaluru during *kharif* season of 2014-2015. The experimental site is located at 12 ° 58' latitude and 77 ° 35' east longitude with an altitude of about 930 m above mean sea level (MSL). The experiment consisting of 18 treatment combinations with three levels each of nitrogen (63, 75 and 90 kg N $ha^{-1}$) and phosphorus (100, 125 and 150 kg $P_2O_5$ $ha^{-1}$) and two levels of potassium (75 and 90 kg $K_2O$ $ha^{-1}$) with 3 replications was laid out in Factorial Randomized Complete Block Design. The soil of the experimental area was red sandy loam (Alfisol) with uniform fertility having pH of 6.46. The experimental land was brought to fine tilth by repeated ploughing, harrowing, clod crushing and formation of raised beds. Before bed preparation recommended quantity of FYM (20 t $ha^{-1}$) was applied commonly to all plots. The experimental site was divided into plots. The treatments were assigned to different plots in each replication by using Random number table. The three nutrients were supplied in the form of straight fertilizers, *viz.*, nitrogen in the form of urea, phosphorus in the form of single super phosphate and potassium in the form of muriate of potash. Seeds were hand dibbled to a depth of 5 cm, at a row spacing of 1.2 mm apart and 30 cm between hill to hill and the sown seeds were covered with soil. Few bio-metric observations like number of leaves per plant, number of branches per pant, leaf area, leaf area index, total fresh weight and dry weight per plant and SPAD meter reading were recorded at different crop growth stages.

## Results and Discussion

In the present study, it was observed that application of different levels of nitrogen had significantly influenced the growth and yield characteristics such as number of branches and leaves per plant, leaf area per plant and leaf area index, SPAD meter reading to measure chlorophyll content, total fresh and dry weights per plant.

Number of leaves (167.19) and branches (7.6) per plant were significantly higher in higher dose of nitrogen (75 kg N $ha^{-1}$). It is also due to the fact that increased application of nitrogen produces more chlorophyll content and more leaf surface area per plant, which is evident in the present study, is helpful for manufacturing of higher photosynthate. Thus has increased the vegetative characters *viz.*, number of branches and leaves per plant. These findings are also in line with Singh and Tripati (1994), Singh and Behera (1999), Kakar *et al.*, (2002), Veeresh, (2003), Yemane & Skjelvag, (2003), EL- Desuki *et al*, (2010), Rabbi *et al.* (2011) and Achakzai (2012).

Leaf area per plant (16313.67 $cm^2$), leaf area index (4.531) and chlorophyll content in leaf (54.39) were significantly higher in 75 kg N $ha^{-1}$. This might be due to the fact that higher level of nitrogen produces more cell division and cell elongation during vegetative growth of the plant. Similar results were in line with those of Escalante *et al.* (1999), Thakur *et al*. (1999), Syed sadar unnisa and Bhaskarareddy (2003), Veeresh (2003) and Behura *et al.* (2006).

Total fresh and dry weight per plant was significantly higher in 75 kg N $ha^{-1}$ at 60 and 100 DAS. This higher fresh weight (0.97 kg and 0.44 kg) and dry matter accumulation (201.68 g and 88.48 g ) might be due to higher leaf area, number of leaves and branches per plant and leaf area index have contributed for more production of photosynthates and thus accumulation of higher fresh and dry weight per plant. The results are in conformity with Rana *et al.* (1998) and Veeresh (2003).

**Table 1a:** Effect of different levels of nitrogen, phosphorus and potassium nutrients on number of branches, leaves per plant, leaf area per plant, leaf area index and SPAD meter reading (chlorophyll content) of pole bean at 60 DAS

| Treatments | | Number of branches per plant | Number of leaves per plant | Leaf area per plant ($cm^2$) | Leaf area index | SPAD meter reading (chlorophyll content) |
|---|---|---|---|---|---|---|
| **Nitrogen Levels (N)** | | | | | | |
| $N_1$ | 63 Kg N $Ha^{-1}$ | 6.86 | 149.50 | 15063.21 | 4.184 | 51.39 |
| $N_2$ | 75 Kg N $Ha^{-1}$ | 7.61 | 167.19 | 16313.67 | 4.531 | 54.39 |
| $N_3$ | 90 Kg N $Ha^{-1}$ | 6.91 | 150.69 | 15060.53 | 4.183 | 50.79 |
| Sem± | | 0.203 | 5.385 | 428.551 | 0.119 | 0.899 |
| C.D. At P= 0.05 | | 0.584 | 15.473 | 1231.333 | 0.342 | 2.582 |
| **Phosphorus Levels(P)** | | | | | | |
| $P_1$ | 100 Kg $P_2O_5$ $Ha^{-1}$ | 6.91 | 152.77 | 15350.96 | 4.264 | 51.83 |
| $P_2$ | 125 Kg $P_2O_5$ $Ha^{-1}$ | 7.44 | 162.97 | 16107.95 | 4.474 | 53.73 |
| $P_3$ | 150 Kg $P_2O_5$ $Ha^{-1}$ | 7.02 | 151.63 | 14978.50 | 4.160 | 51.02 |
| Sem± | | 0.203 | 5.385 | 428.551 | 0.119 | 0.899 |
| C.D. At P= 0.05 | | NS | NS | NS | NS | NS |
| **Potassium Levels (K)** | | | | | | |
| $K_1$ | 75 Kg $K_2O$ $Ha^{-1}$ | 7.24 | 158.11 | 15681.07 | 4.355 | 52.27 |
| $K_2$ | 90 Kg $K_2O$ $Ha^{-1}$ | 7.02 | 153.48 | 15277.20 | 4.243 | 52.12 |
| Sem± | | 0.166 | 4.397 | 349.910 | 0.097 | 0.734 |
| C.D. At P= 0.05 | | NS | NS | NS | NS | NS |

DAS= Days after sowing. NS = Non-significant.

**Table 1b:** Interaction effect of nitrogen and phosphorus (NxP), phosphorus and potassium (PxK) and nitrogen and potassium (NxK) nutrients on number of branches, leaves per plan, leaf area per plant, leaf area index and SPAD meter reading (chlorophyll content) of pole bean at 60 DAS.

| Treatments | | Number of branches per plant | Number of leaves per plant | Leaf area per plant ($cm^2$) | Leaf area index | SPAD meter reading (chlorophyll content) |
|---|---|---|---|---|---|---|
| **Nitrogen x Phosphorus (NxP)** | | | | | | |
| $N_1P_1$ | 63:100 kg N : $P_2O_5$ $ha^{-1}$ | 6.58 | 141.42 | 14050.65 | 3.902 | 48.88 |
| $N_1P_2$ | 63:125 kg N : $P_2O_5$ $ha^{-1}$ | 6.75 | 145.16 | 15079.23 | 4.189 | 52.16 |
| $N_1P_3$ | 63:150 kg N : $P_2O_5$ $ha^{-1}$ | 7.25 | 161.91 | 16059.75 | 4.461 | 53.15 |
| $N_2P_1$ | 75:100 kg N : $P_2O_5$ $ha^{-1}$ | 7.08 | 159.75 | 16240.31 | 4.511 | 54.01 |
| $N_2P_2$ | 75:125 kg N : $P_2O_5$ $ha^{-1}$ | 8.42 | 185.16 | 17193.48 | 4.776 | 56.11 |
| $N_2P_3$ | 75:150 kg N : $P_2O_5$ $ha^{-1}$ | 7.33 | 156.66 | 15507.19 | 4.307 | 53.05 |
| $N_3P_1$ | 90:100 kg N : $P_2O_5$ $ha^{-1}$ | 7.08 | 157.16 | 15761.91 | 4.378 | 52.61 |
| $N_3P_2$ | 90:125 kg N : $P_2O_5$ $ha^{-1}$ | 7.16 | 158.58 | 16051.13 | 4.458 | 52.92 |
| $N_3P_3$ | 90:150 kg N : $P_2O_5$ $ha^{-1}$ | 6.50 | 136.33 | 13368.56 | 3.713 | 46.85 |
| SEm± | | 0.282 | 7.462 | 742.272 | 0.206 | 1.556 |
| C.D. at P= 0.05 | | 0.810 | 21.438 | 2132.730 | 0.592 | 4.472 |
| **Phosphorus x Potassium (PxK)** | | | | | | |
| $P_1K_1$ | 100:75 kg $P_2O_5$ : $K_2O$ $ha^{-1}$ | 6.89 | 152.77 | 15464.38 | 4.295 | 50.94 |
| $P_1K_2$ | 100:90 kg $P_2O_5$ : $K_2O$ $ha^{-1}$ | 6.94 | 152.78 | 15237.54 | 4.232 | 52.73 |
| $P_2K_1$ | 125:75 kg $P_2O_5$ : $K_2O$ $ha^{-1}$ | 7.50 | 163.89 | 16140.89 | 4.483 | 53.42 |
| $P_2K_2$ | 125:90 kg $P_2O_5$ : $K_2O$ $ha^{-1}$ | 7.38 | 162.05 | 16075.01 | 4.465 | 54.04 |
| $P_3K_1$ | 150:75 kg $P_2O_5$ : $K_2O$ $ha^{-1}$ | 7.33 | 157.67 | 15437.94 | 4.288 | 52.44 |
| $P_3K_2$ | 150:90 kg $P_2O_5$ : $K_2O$ $ha^{-1}$ | 6.72 | 145.61 | 14519.07 | 4.033 | 49.59 |
| SEm± | | 0.287 | 7.616 | 606.062 | 0.168 | 1.271 |
| C.D. at P=0.05 | | NS | NS | NS | NS | NS |
| **Nitrogen x Potassium (NxK)** | | | | | | |
| $N_1K_1$ | 63:75 kg N : $P_2O_5$ $ha^{-1}$ | 6.78 | 148.27 | 14890.05 | 4.136 | 50.45 |
| $N_1K_2$ | 63:90 kg N : $P_2O_5$ $ha^{-1}$ | 7.89 | 173.27 | 16968.36 | 4.713 | 55.01 |
| $N_2K_1$ | 75:75 kg N : $P_2O_5$ $ha^{-1}$ | 7.05 | 152.77 | 15184.80 | 4.217 | 51.34 |
| $N_2K_2$ | 75:90 kg N : $P_2O_5$ $ha^{-1}$ | 6.94 | 150.72 | 15236.37 | 4.231 | 52.34 |
| $N_3K_1$ | 90:75 kg N : $P_2O_5$ $ha^{-1}$ | 7.33 | 161.11 | 15658.97 | 4.349 | 53.78 |
| $N_3K_2$ | 90:90 kg N : $P_2O_5$ $ha^{-1}$ | 6.78 | 148.61 | 14936.27 | 4.148 | 50.24 |
| SEm± | | 0.287 | 7.616 | 606.062 | 0.168 | 1.271 |
| C.D. at P=0.05 | | NS | NS | NS | NS | NS |

DAS= Days after sowing. NS = Non-significant.

**Table 2a:** Effect of different levels of nitrogen, phosphorus and potassium nutrients on fresh and dry weight per plant of pole bean at 60 and 100 DAS

| Treatments | | Fresh weight per plant (kg) | | Dry weight per plant (g) | |
|---|---|---|---|---|---|
| | | 60 DAS | 100 DAS | 60 DAS | 100 DAS |
| **Nitrogen Levels (N)** | | | | | |
| $N_1$ | 63 kg N $ha^{-1}$ | 0.88 | 0.42 | 184.88 | 86.55 |
| $N_2$ | 75 kg N $ha^{-1}$ | 0.97 | 0.44 | 201.68 | 88.48 |
| $N_3$ | 90 kg N $ha^{-1}$ | 0.87 | 0.42 | 182.18 | 86.46 |
| SEm± | | 0.026 | 0.002 | 5.012 | 0.692 |
| C.D. at P=0.05 | | 0.07 | 0.006 | 14.401 | 1.988 |
| **Phosphorus Levels (P)** | | | | | |
| $P_1$ | 100 kg $P_2O_5$ $ha^{-1}$ | 0.89 | 0.42 | 186.71 | 86.70 |
| $P_2$ | 125 kg $P_2O_5$ $ha^{-1}$ | 0.95 | 0.44 | 197.33 | 87.84 |
| $P_3$ | 150 kg $P_2O_5$ $ha^{-1}$ | 0.87 | 0.42 | 184.70 | 86.95 |
| SEm± | | 0.026 | 0.010 | 5.012 | 1.042 |
| C.D. at P=0.05 | | 0.07 | NS | NS | NS |
| **Potassium Levels (K)** | | | | | |
| $K_1$ | 75 kg $K_2O$ $ha^{-1}$ | 0.92 | 0.43 | 192.65 | 87.52 |
| $K_2$ | 90 kg $K_2O$ $ha^{-1}$ | 0.89 | 0.42 | 186.51 | 86.81 |
| SEm± | | 0.021 | 0.008 | 4.092 | 0.851 |
| C.D. at P=0.05 | | NS | NS | NS | NS |

DAS= Days after sowing. NS = Non-significant.

**Table 2b:** Interaction effect of nitrogen and phosphorus (NxP), phosphorus and potassium (PxK) and nitrogen and potassium (NxK) nutrients on fresh and dry weight per plant of pole bean at 60 and 100 DAS**.**

| Treatments | | Fresh weight per plant (kg) | | Dry weight per plant (g) | |
|---|---|---|---|---|---|
| | | **60 DAS** | **100 DAS** | **60 DAS** | **100 DAS** |
| **Nitrogen x Phosphorus (NxP)** | | | | | |
| $N_1P_1$ | 63:100 kg N : $P_2O_5$ $ha^{-1}$ | 0.81 | 0.41 | 174.96 | 85.57 |
| $N_1P_2$ | 63:125 kg N : $P_2O_5$ $ha^{-1}$ | 0.86 | 0.42 | 178.18 | 85.96 |
| $N_1P_3$ | 63:150 kg N : $P_2O_5$ $ha^{-1}$ | 0.96 | 0.43 | 201.49 | 88.13 |
| $N_2P_1$ | 75:100 kg N : $P_2O_5$ $ha^{-1}$ | 0.94 | 0.43 | 192.63 | 87.85 |
| $N_2P_2$ | 75:125 kg N : $P_2O_5$ $ha^{-1}$ | 1.06 | 0.47 | 221.89 | 89.93 |
| $N_2P_3$ | 75:150 kg N : $P_2O_5$ $ha^{-1}$ | 0.91 | 0.43 | 190.53 | 87.64 |
| $N_3P_1$ | 90:100 kg N : $P_2O_5$ $ha^{-1}$ | 0.92 | 0.42 | 192.54 | 86.67 |
| $N_3P_2$ | 90:125 kg N : $P_2O_5$ $ha^{-1}$ | 0.92 | 0.43 | 191.92 | 87.62 |
| $N_3P_3$ | 90:150 kg N : $P_2O_5$ $ha^{-1}$ | 0.76 | 0.40 | 162.09 | 85.10 |
| SEm± | | 0.044 | 0.008 | 8.681 | 0.903 |
| C.D. at P= 0.05 | | 0.126 | 0.023 | 24.943 | 2.594 |
| **Phosphorus x Potassium (PxK)** | | | | | |
| $P_1 K_1$ | 100:75kg $P_2O_5$: $K_2O ha^{-1}$ | 0.89 | 0.42 | 191.33 | 86.75 |
| $P_1 K_2$ | 100:90kg $P_2O_5$:$K_2O$ $ha^{-1}$ | 0.89 | 0.42 | 182.09 | 86.64 |
| $P_2 K_1$ | 125:75kg $P_2O_5$:$K_2O$ $ha^{-1}$ | 0.96 | 0.44 | 196.90 | 88.27 |
| $P_2K_2$ | 125:90kg $P_2O_5$:$K_2O$ $ha^{-1}$ | 0.94 | 0.43 | 197.76 | 87.40 |
| $P_3 K_1$ | 150:75kg $P_2O_5$:$K_2O$ $ha^{-1}$ | 0.91 | 0.42 | 189.72 | 87.40 |
| $P_3 K_2$ | 150:90kg $P_2O_5$:$K_2O$ $ha^{-1}$ | 0.85 | 0.41 | 179.69 | 87.53 |
| SEm± | | 0.036 | 0.014 | 7.088 | 1.474 |
| C.D. at P=0.05 | | NS | NS | NS | NS |
| **Nitrogen x Potassium (NxK)** | | | | | |
| $N_1 K_1$ | 63:75 kg N : $P_2O_5$ $ha^{-1}$ | 0.87 | 0.41 | 183.93 | 86.36 |
| $N_1 K_2$ | 63:90 kg N : $P_2O_5$ $ha^{-1}$ | 1.01 | 0.45 | 206.76 | 89.67 |
| $N_2 K_1$ | 75:75 kg N : $P_2O_5$ $ha^{-1}$ | 0.89 | 0.43 | 187.27 | 86.53 |
| $N_2K_2$ | 75:90 kg N : $P_2O_5$ $ha^{-1}$ | 0.88 | 0.42 | 185.84 | 86.75 |
| $N_3 K_1$ | 90:75 kg N : $P_2O_5$ $ha^{-1}$ | 0.94 | 0.44 | 196.61 | 87.28 |
| $N_3 K_2$ | 90:90 kg N : $P_2O_5$ $ha^{-1}$ | 0.85 | 0.41 | 177.09 | 86.39 |
| SEm± | | 0.036 | 0.014 | 7.088 | 1.474 |
| C.D. at P=0.05 | | NS | NS | NS | NS |

DAS= Days after sowing. NS = Non-significant.

## References


1. Achakzai AKK. Effect of various levels of nitrogen fertilizer on some vegetative growth attributes of pea (*Pisum sativum L.*) cultivars. Pakistan. J Bot. 2012; 44(2): 655- 659.
2. Behura AK, Mahapatra PK, Swain D. Effect of irrigation and nitrogen on physiological growth parameters, yield and yield attributes of rajmash (*Phaseolus vulgaris* L.). Res. On crops. 2006; 7:92-95.
3. Broun PE, Creelman RA, Dubell AN, Heard JE, Jiang CZ, Keddie J. Biochemistry-Related Polynucleotides and Polypeptides in Plants. United States Patent No. 7135616, 2006.
4. El-Desuki M, Magda M, Hafez, Mahmoud AR, ABD EL-AL FS. Effect of organic and bio fertilizers on the plant growth, green pod yield, quality of pea. Int. J Acad. Res. 2010; 2:87-92.
5. Escalante A, Rodriguez MT, Escalante E. Effect of nitrogen on development and abscission of reproductive organs of beans. *Agronomia Mesoamericana.*, 1999; 10:47-53.
6. Hörtensteiner S, Feller U. Nitrogen Metabolism and Remobilization during Senescence. Journal of Experimental Botany. 2000; 53:927-937.
7. Kakar AA, Saleem M, Rahim Shah, Qaim Shah SA. Growth and marketable green pod yield performance of pea (*Pisum sativum* L.) under varying levels of NPK fertilizers. Asian J Plant Sci. 2002; 1(5):532-534.
8. Lambrecht I, Maertens M, Vranken L, Merckx R, Vanlauwe B. Heterogeneous Preferences for Integrated Soil Fertility Management: A Choice Experiment on Climbing Beans in Burundi. Bio-economics Working Paper Series, Working Paper, 2013. 2013/32013.
9. Nienhuis J, Singh S. Genetics of Seed Yield and its Components in Common Bean (*Phaseolus vulgaris* L.) of Middle-American Origin. *Plant Breeding.* 1988; 101:143-154.
10. Pretorius H. The Ability of a Novel Compound to Enhance the Effect of Urea on Nitrogen Deficient Tomatoes. University of the Free State, Bloemfontein, 2009.
11. RABBI AKMZ, PAUAL AK, SAKAR JR. Effect of Nitrogen and molybdenum on the growth and yield of Garden pea (*Pisum sativum L.*). IJBSM. 2011; 2(2):230-235.
12. Rana Ns, Singh R, Ahlawat Ips. Dry matter production and nutrient uptake in French bean (*Phaseolus vulgaris L.)* as affected by nitrogen and phosphorus application. Indian J. Agron. 1998; 43:114-117.
13. Sharma HM, Singh RNP, Singh H, Sharma RPR. Effect of rates and timings of N application on growth and yield of winter rajmash. Indian J. Pulse Res. 1996; 9:23-25.
14. SINGH DN, BEHERA. Response of French bean (*Phaseolus vulgaris* L.) to fertilizers and spacing. Indian J Agron. 1999; 44:597-600
15. SINGH DN, TRIPATHI P. Effect of NPK fertilizers and spacing on growth and yield of French bean. Veg. Sci. 1994; 21:7-11.
16. SSALI H, KEYA SO. The effect of phosphorus and nitrogen fertilizer level on nodulation, growth and dinitrogen fixation of three bean cultivars. Trop. Agric. 1986; 63:105-109.

17. Syed Sadar Unnisa, Bhaskara Reddy K. Effect of nitrogen and phosphorus on growth, yield and quality of French bean (*Phaseolus vulgaris* L.). The Andhra Agric. J. 2003; 50:258-262
18. Thakur RN, Arya PS, Thakur SK. Response of French bean (*Phaseolus vulgaris* L.) varieties to fertilizer levels, Rhizobium inoculation and their residual effect on onion (*Allium cepa*) in mid-hills of north-western Himalayas. Indian J Agric. Sci. 1999; 69:416-418.
19. Veeresh NK. Response of French bean (*Phaseolus vulgaris* L.) to fertilizer levels in Northern Transitional Zone of Karnataka. *M.Sc (Agri.) Thesis, Univ. Agric. Sci.,* Dharwad. 2003, 37-79.
20. YEMANE A, SKJELVAG AO. Effects of fertilizer phosphorus on yield traits of dekoko (*Pisum sativum* var. abyssinicum) under field conditions. J Agron. & Crop Sci. 2003; 189:14-20.