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To assess the response of nitrogen on growth and yield of French bean (*Phaseolus vulgaris* L.)`

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Abstract
Field experiment entitled "To assess the response of nitrogen on growth and yield of French bean (*Phaseolus vulgaris* L.)" Have been conducted at the research farm, AKS University, Sherganj Satna. During *Rabi* season of 2015-16. Experiment comprised of four levels of Nitrogen (0 kg N/ha), (30kg N/ha), (60kg N/ha) and 90 N/ha. Experiment was laid out in Randomized Block Design with three replications. Nitrogen levels significantly influenced growth, yield and yield attributes such as height of the plant, number of leaves per plant, 1000 seed weight and weight of pods per plant were also affected by nitrogen levels, when nitrogen applied @ 90 kg/ha highest pod yield (53.30 q/ha) was obtained.

Keywords: French bean (*Phaseolus vulgaris* L.) nitrogen, growth and yield

Introduction
French bean (*Phaseolus vulgaris* L.) belongs to the family Fabaceae and is also known as Rajma, Rajmash, Kindey bean, Snap bean, field bean and pole bean etc. However, common beans are found in Europe, Africa and Asia and presently it is been grown throughout the cooler tropics. (Chatterjee and Bhattacharyya (1986) [2]. There are a large number of cultivars which have been developed, however, they are group in two type's viz., bush and pole type. In pole type staking is done by poles and dry branches of plants with wide spaced than the former one. French bean is grown in different parts of the world for its mature dry seeds and immature tender green pods. In Northern India, The dry seeds of French bean give better price than other pulse crops. Besides, it is more nutritious when it is used as vegetable. The dry seeds of French beans is canned also and exported to other countries of the world. The tender parts of French bean used for vegetable purposes can be harvested in about two months after sowing. It is quite nutritious and good source of Protein, Carbohydrates, minerals and crude fibre. Whereas crude proteins are stored in the cotyledons of French bean. (Singh *et al.*, 1997) [9]. Traditionally it is crop of temperate regions and its cultivation is widely done in hilly tracts of Jammu & Kashmir, Himachal Pradesh and Uttar Pradesh. Whereas its cultivation is mainly restricted to hilly regions of north India, However, its consumption is more in plains of north and central India. Besides, its cultivation is also done in some parts of Maharashtra, Andhra Pradesh, western and eastern Ghats 'and north-east plains of India where winter is mild and area found is also frost free. Recently its cultivation has been extended to northern plain zone of India and Chandra and Ali (1986) [1] exploited the feasibility of growing Rajma as a potential Rabi crop in the plains of north India. Possibility of its cultivation as a Rabi crop in different agro-climatic situations of Bihar has also been revealed by Sharma *et al.* (1990) [8]. The general recommendation of reduced nitrogen application to legume crops is due to its ability to fix atmospheric nitrogen. French bean readily responds to large dose of nitrogen. Soil fertility and plant density are the two most important factors of crop production. The role of adequate plant spacing is considered as major factor in determining the yield of French bean. The yield of French bean may be increased throw an appropriate combination of plant spacing and nitrogen application. (Dhanjal *et al.*, 2001) [3].

Materials and Methods

The present research works 'To assess the response of nitrogen on growth and yield of French bean (*Phaseolus vulgaris L.*)"Have been undertaken at the Department of Horticulture, AKS University, Satna (M.P.) during 2015-2016. Experiment has been conducted at the farm of AKS University. Experimental plot was located about 2000 meters East of University, Campus. Satna. Experimental design - RBD (Randomized Block Design), Number of replications - 03, Number of treatments -12, Total number of plots - 36, Plot size - 3.0 × 1.0 $m^{2,}$ Row to row distance - 30 cm, Plant to plant distance -10, 15 and 30 cm, Total area under layout - 10.5 × 16.5 m^2 and Variety - Contender etc.

Observation

i) **Plant height:** The plant height was measured at 25, 35 and at 45 days after sowing (DAS) by placing a meter scale from ground level to the tip of the largest leaf. Plant heights of 10 randomly selected plants per plot were recorded and mean was calculated in centimeter.
ii) **Number of leaves/plant:** The number of leaves from the 10 randomly selected plants was counted in each treatment and the mean was calculated.
iii) **Branches per plant:** The number of branches from the ten randomly-selected plants from each plot was recorded at final harvest and the average was worked out for each treatment.
iv) **Days to first flowering:** The first flowering for different treatments were visually observed and the dates were noted.
v) **Number of flowers per plant:** The numbers of flowers per plant were recorded from the ten randomly- selected plants and the mean values were calculated.
vi) **Number of pods per plant**: The numbers of pods/plant were counted from ten randomly-selected plants and the mean values were calculated.
vii) **Length of green pods**: Twenty pods from each randomly-selected plants was measured using centimeter scale and the mean values were calculated in each treatment and then expressed in centimeter.
viii) **Diameter of green pod**: The diameter of twenty randomly-selected green pods from each plot were measured in centimeter with the help of slide calipers and the mean diameter was calculated for each treatment.
ix) **Number of seeds per green pod:** The numbers of seeds per green pod were counted from the ten randomly-selected plants and the mean values were calculated for each treatment.
x) **Test weight of 1000 seeds:** The seeds of sample plants were collected and 1000-seeds were weighed and their average was worked out for each treatment.
xi) **Weight of pods per plant:** The pods of ten sample plants were taken and their weight was recorded through physical balance. The average was worked out in grams for each treatment.
xii) **Pod yield (q/ha)**: The pods obtained from each net plot were weighted for each treatment and the pods per plot was converted into quintals per hectare by multiplying with the factors.

Results

Plant height: The results pertaining to the main effect of nitrogen on plant height of French bean have been presented at 25, 35 DAS and at harvest stages. The main effect of nitrogen revealed that there was significant difference in plant height due to different levels of nitrogen used. The plant height was gradually increased with increasing levels of nitrogen. The maximum plant height (31.89 cm) was found from 90 kg N/ha and the minimum (29.91 cm) was found from the control treatment at 25 DAS. At 35 DAS, the longest plant height (48.11 cm) was recorded from 90 kg N/ha and lowest plant height (44.57 cm) was recorded at 0 kg N/ha. The longest plant height (50.70 cm) was found from 90 kg N/ha and the shortest height (47.98 cm) was found from 0 kg N/ha at harvest.

Number of leaves per plant: The number of leaves per plant was significantly influenced by the application of nitrogen levels. The maximum number of leaves per plant (3.41cm) was observed at 90 kg N/ha and lowest number of leaves per plant (3.06cm) was observed at 0 kg N/ha at 25 DAS. At 35 DAS the largest number of leaves (4.21cm) was found at 90kg N/ha and shortest number of leaves (3.77 cm) was found at 0kg N/ha. The maximum number of leaves per plant (11.21 cm) was found at 90 kg N/ha and minimum number of leaves per plant (7.75 cm) was found at 0 kg N/ha at harvest.

Number of branches per plant: Number of branches per plant varied significantly due to nitrogen levels in French bean. The maximum number of branches per plant (3.64 cm) was recorded from 90 kg N/ha and the minimum number of branch per plant (2.51) was recorded from 0kg N/ha at 25 days after sowing (DAS). At 35 days after sowing (DAS) the largest number of branch per plant (5.84) was observed in 90 kg N/ha and shortest number of branch per plant (4.04) was observed in 0kg N/ha. The highest number of branch per plant (6.12) was found from 90 kg N/ha and the lowest number of branch per plant (4.28) was found from 0 kg N/ha at harvest.

Days of first flowering: Days taken to first flowering varied significantly due to the influence of nitrogen level (Table 1.0).

Table 1: Table showing days to first flowering of French bean as influenced by levels of nitrogen

Levels of nitrogen	Days to first flowering
N_0 = 0 kg N/ha	30.07
N_1 = 30 kg N/ha	34.06
N_2 = 60 kg N/ha	31.89
N_3 = 90 kg N/ha	35.79
SEm±	0.16
CD (P=0.05)	0.46

Number of flower per plant

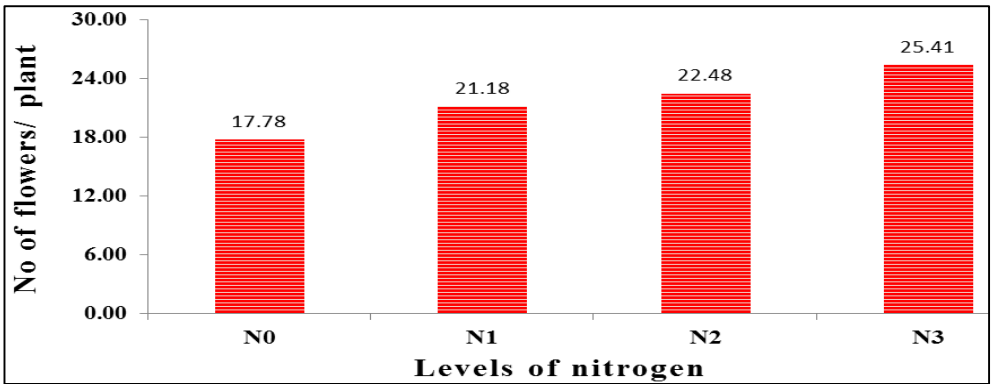

Fig 1: Number of flowers/ plant of French bean as influenced by levels of nitrogen

Number of pods per plant: There was influence due to the effect of nitrogen on the number of pods per plant (Table 2.0).

Table 2: Table showing number of pods/ plant of French bean as influenced by levels of nitrogen

Levels of nitrogen	Number of pods
N_0 = 0 kg N/ha	13.25
N_1 = 30 kg N/ha	15.79
N_2 = 60 kg N/ha	16.76
N_3 = 90 kg N/ha	19.51
SEm±	0.40
CD (P=0.05)	1.18

Length of green pod (cm): Nitrogen had significant influence on the length of green pod. The highest length of green pod of French bean (14.23cm) was found in the crop grown with the highest dose of nitrogen i. e 90 kg N/ha and the lowest length of green pod (10.40cm) was found from the control i.e. no nitrogen was applied.

Diameter of green pod (cm): The result on the main effect of nitrogen revealed that the diameter of green pod was significantly influenced by different levels of nitrogen used. The highest diameter of green pod (1.70cm) found from the crop receiving 90 kg N/ha and the lowest (1.18 cm) in control nitrogen application.

Number of seeds per green pod: The result on the main effect of nitrogen on the number of seeds per green pod was found to be significantly influenced. The highest number of seeds (5.71) per green pod was found in the crop which received 90 kg N/ha and the lowest number of seeds (3.97) obtained from control treatment.

Test weight (1000 seed weight g): Application of different doses of nitrogen had significant effect on 1000 seed weight. The highest 1000 seed weight (513.61g) was found in case of 90 kg N/ha nitrogen and the (377.38g) was found in control i.e. 0 kg N/ha nitrogen.

Weight of pods per plant: Different doses of nitrogen showed a marked influence on the pod weight per plant of French bean. It may be noted that the highest pod weight (57.79g) was obtained from 90 kg N/ha and the lowest (42.75g) pod weight from the plant of control i.e. 0 kg N/ha.

Pod yield (q/ha): Different doses of nitrogen showed a marked influence on pod yield of French been. It may be noted that the highest pod yield (53.30 q/ha) was obtain from 90 kg N/h and the lowest (47.27 q/ha) pod yield from control i.e. no application of N

Discussion

The results of the experiment as influenced by combinations of nitrogen and plant spacing's have been presented and discussed in this chapter under the following heads.

Plant height: The results on the effect of nitrogen levels on plant height of French bean were recorded at 25, 35 DAS and at harvest. The effect of nitrogen revealed that there was significant difference in plant height due to different levels of applied nitrogen. The plant height was gradually increased with the increasing levels of nitrogen. At 25 DAS, the maximum plant height (31.89cm) was found from 90 kg N/ha and the minimum (29.91cm) from the control treatment. At 35 DAS, the longest plant height (48.11cm) was recorded from 90 kg N/ha and lowest plant height (44.57) at 0 kg N/ha. Similarly, the longest plant height (50.70cm) was found from 90 kg N/ha and the shortest height (47.98cm) was found from 0 kg N/ha at harvest. This was probably due to the fact that the higher level of nitrogen enhanced vegetative growth of plant. These results are in close agreement with the findings of Chatrabhuji *et al.* (2001), Patel *et al.* (2003) [7] and Tripathi *et al.* (2006) [10].

Number of leaves per plant: The number of leaves per plant was influenced significantly by the application of nitrogen levels. The highest number of leaves per plant (3.41) was observed at 90 kg N/ha and lowest (3.06cm per plant) at 0 kg N/ha at 25 DAS. At 35 DAS, the maximum number of leaves (4.21) was found at 90 kg N/ha and minimum number of leaves (3.77) was observed at 0 kg N/ha. At harvest stage, the maximum number of leaves (11.21) per plant was found at 90 kg N/ha and minimum number of leaves per plant (7.75) was found at 0 kg N/ha. The present results are in agreement with those of Geetha and Varughese (2001) [4], Patel *et al.* (2003) [7], Tripathi *et al.* (2006) [10] and Kumawat *et al.* (2009) [8].

Number of branches per plant: The number of branches per plant varied significantly with the nitrogen applications in French bean. The maximum number of branches (3.64cm) per plant was recorded from 90kg N/ha and the minimum number of branches per plant (2.51) was recorded from 0 kg N/ha at 25 days after sowing. At 35 days after sowing, the largest number of branches (5.84) per plant was observed in 90kg N/ha and shortest number (4.04) of branches per plant was observed in 0 kg N/ha. The highest number (6.12) of branches

per plant was found from 90kg N/ha and the lowest number (4.28) of branches per plant was found from 0kg N/ha. It was found that increased rate of N application increased the number of branches per plant. It was possibly due to the fact that nitrogen at the higher rate promoted more vegetative growth which resulted in higher number of branches per plant.

Days to first flowering: Days taken to first flowering was found to vary significantly due to the applied nitrogen levels. The plants which received 90 kg N/ha have taken the longest time (35.79 days) for flowering, while under the control treatment, the plants produced flower within the shortest time (37.2 days). In case of plants receiving higher dose of nitrogen have taken long duration to complete vegetative growth which resulted in longer time of flowering. On the other hand in case of control treatment, plants received less supply of nitrogen which resulted in shorter vegetative period.

Number of flowers per plant: The results on the effect of nitrogen had significant effect on the number of flowers per plant. The number of flowers/plant was increased with increasing levels of nitrogen. The maximum number of flowers (25.41/plant) was found under 90 kg N/ha nitrogen, while the minimum number of flowers (17.78/plant) was found in case of control treatment where no nitrogen was not applied. Nitrogen promoted vegetative growth and caused maximum flowering.

Number of pods per plant: There was influence due to the effect of nitrogen on the number of pods per plant. Higher number of pods (19.51) per plant was obtained from 90 kg N/ha on the other hand in case of the plant grown with 0 kg N/ha had lower number of pods (13.25) per plant. It may be due to sufficient supply of nitrogen to the developed pod bearing branches. On the other hand, inadequate supply of nitrogen was available to plants in case control treatment for pod bearing branches. As a result, number of pods/plant was decreased with the decreasing levels of nitrogen. It may be due to sufficient supply of nitrogen to the developed pod bearing branches. On the other hand, inadequate supply of nitrogen, in case of control treatment, probably disturbed the normal growth of plants and formation of pod-bearing branches. As a result, number of pods/plant was decreased with the decreasing level of nitrogen. The present results are agreement with that of Patel *et al.* (2003) [7], Tripathi *et al.* (2006) [10] and Kumawat *et al.* (2009) [8] who reported significant differences in the number of pods per plant with different levels of applied nitrogen.

Length of green pod: The nitrogen levels had significant influence on the length of green pod. The highest length of green pod of French bean (14.23 cm) was found when the crop was grown with the highest dose of nitrogen (90 kg N/ha) and the lowest length of green pod (10.40 cm) was found from the control where no nitrogen was applied. Tripathi *et al.* (2006) [10], Kumawat *et al.* (2009) [8] and Muhammad *et al.* (2009) [6] also reported that applied N significantly increased seed yield and pod length.

Diameter of green pod: The result on the main effect of nitrogen revealed that the diameter of green pod was significantly influenced due to different levels of applied nitrogen. The highest diameter of green pod (1.70 cm) found from the crop receiving 90 kg N/ha and the lowest (1.18 cm) in case of without nitrogen application.

Number of seeds per green pod: The results on the main effect of nitrogen levels on the number of seeds per green pod were found to be significantly influenced. The highest number of seeds (5.71 per green pod) was found in the crop which received 90 kg N/ha and the lowest number of seeds (3.97/plant) obtained from control treatment. The increase in seed number of French bean due to higher nitrogen application was probably owing to improved growth and yield attributes, as reported by Tripathi *et al.* (2006) [10] and Kumawat *et al.* (2009) [8].

Test weight of 1000 seeds: Application of different doses of nitrogen had significant effect on 1000 seed weight. The highest 1000-seed weight (51.36 g) was found in case of 90 kg N/ha nitrogen and 37.74 g was found in control (0 kg N/ha). These results are in agreement with the findings of Muhammad *et al.* (2009) [6] who recorded the maximum 1000 seed weight of French bean at 90 kg N/ha. Kumawat *et al.* (2009) [8] worked on N-fertilizer in French bean and observed that the 1000-seed weight was increased with increase in N rate.

Weight of pods per plant: The application of different doses of nitrogen showed a marked influence on the pod weight per plant of French bean. It may be noted that the highest pod weight (57.79 g) was obtained from 90 kg N/ha and the lowest (42.75 g) from 0 kg N/ha.

Pod yield (q/ha): The variation in pod yield was found to be significant due to different levels of nitrogen. Nitrogen applied at 90 kg N/ha produced the highest pod yield (53.30 q/ha) and the lowest pod yield (47.27 q/ha) was obtained from the control where no nitrogen was applied. Also found good response of French bean to applied nitrogen. Seed yield was increased with the increase of nitrogen levels. These findings are in agreement with those of Patel *et al.* (2003) [7], Tripathi *et al.* (2006) [10] and Kumawat *et al.* (2009) [8].

Summary and Conclusion: The experiment comprised two factors namely, nitrogen levels (0, 30, 60 and 90 kg/ha) and plant spacing (30 x 10cm, 30 x 15cm, 30 x 20cm). The experiment consisted of twelve treatment combinations which were laid out in randomized block design with three replications. The size of each unit plot was 1.0m x 3.0m. The seeds of French bean were sown in each plot on 1st week of December, 2015. Five plants were randomly-selected from each plot to record data on growth of plants, yield components and finally yield. The collected data were subjected to statistical analysis an order is draw the valid conclusion and the unit C.D value. In the present study, the application of nitrogen levels showed significant effect on most of the growth parameters, yield components and yield of French bean. The highest plant height was recorded with nitrogen level of 90 kg/ha from 25 days after sowing up to the harvest stage and become statistically similar in different levels of nitrogen. Nitrogen levels had significant effect on plant height, number of leaves per plant, branch per plant, number of flowers, pods/plant, and pod yield per hectare of French bean. The highest diameter of green pod (1.70 cm) was found from the crop receiving 90 kg N/ha and the lowest (1.18 cm) in control treatment (0 kg N/ha). The highest diameter of green pod (1.70 cm) was found from the crop receiving 90 kg N/ha and the lowest diameter of green pod (1.18 cm) in control treatment (0 kg N/ha). The highest number of seeds (5.71) per green pod was noted in the crop

which received 90 kg N/ha and the lowest number of seeds (3.97) obtained from control treatment. The highest 1000-seed weight (513.61g) was found in case of 90 kg N/ha nitrogen and the 377.38g were found in case of no nitrogen. From the results summarized above, the following conclusions are being warranted. Incorporation of 90 kg N/ha caused significantly maximum yield of 53.30 q/ha.

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