Journal of Advances in Biology & Biotechnology

Volume 27, Issue 10, Page 132-137, 2024; Article no.JABB.123926
ISSN: 2394-1081

Growth, Development, Yield Attributes and Yield of French Bean (*Phaseolus vulgaris* L.) as Influenced by Doses and Methods of Nitrogen Application

Shashidhar M P [a*] and A.K. Singh [a]

[a] *School of Natural Resource Management, College of Post Graduate Studies in Agricultural Sciences, Central Agricultural University (I), Umiam, Meghalaya - 793103, India.*

Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.9734/jabb/2024/v27i101437

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/123926

Original Research Article

Received: 16/07/2024
Accepted: 18/09/2024
Published: 21/09/2024

ABSTRACT

A field experiment was carried out at School of Natural Resource Management, College of Post Graduate Studies in Agricultural Sciences, CAU, Umiam, Meghalaya during summer season 2021 to study the effect of different doses and application methods of nitrogen on the growth, yield and yield attributes of Frenchbean (*Phaseolus vulgaris* L.). The experiment comprised of four doses of nitrogen *viz.,*0, 30, 60, 90 kg ha^{-1} and two methods of its application i.e., full dose as nitrogen as basal application and 2/3 of nitrogen dose as basal and 1/3 of nitrogen dose split application at

**Corresponding author: E-mail: shashidharmp00@gmail.com;*

Cite as: *M P, Shashidhar, and A.K. Singh. 2024. "Growth, Development, Yield Attributes and Yield of French Bean (Phaseolus Vulgaris L.) As Influenced by Doses and Methods of Nitrogen Application". Journal of Advances in Biology & Biotechnology 27 (10):132-37. https://doi.org/10.9734/jabb/2024/v27i101437.*

active branching stage. The experiments consist of a total of 7 treatments laid out in Randomized Block Design with four replications. Growth parameters such as plant height and number of branches per plant in frenchbean showed a significant increase at all the growth stages with increase in nitrogen doses. Maximum plant height (39.35 cm) and number of branches per plant (3.56) were observed with application of 90 kg N ha^{-1}. The grain yield (762.32 kg ha^{-1}) was observed with application of 90 kg N ha^{-1} whereas, lowest grain yield was observed in control (146.25 kg ha^{-1}). Yield attributes were observed to follow the same trend with highest number of pods per plant as 5.44, number of seeds per pod as observed significantly more values of all the above said parameters of growth and yield of frenchbeanin comparison to full dose of nitrogen as basal alone. Therefore, the finding of this experiment suggest that the frenchbean should be grown with 90 kg N ha^{-1} and 2/3 of this dose should be applied as basal application while remaining 1/3 should be applied as top dressing at active branching stage for better growth and yield of frenchbean.

Keywords: Nitrogen; basal; split application; French bean.

1. INTRODUCTION

“French bean (*Phaseolus vulgaris* L.) is one of the main leguminous crops grown in the North Eastern region. French bean is an important nutritive legume having 22.25% protein in grain and 1-2.4% in green pods. It supplies 1.7 g protein, 50 mg calcium, 28 mg phosphorus, 1.7 mg iron, 132 mg carotene, 0.08 mg thiamine, 0.06 mg riboflavin, 24 mg vitamin C per 100 g. of edible pods. It is widely cultivated in the temperate, sub-tropical and tropical regions with the optimum mean temperature for French bean is 20-25ºC for its growth and better productivity” [1]. It is grown as pods and seeds in NER all through the spring and summer. It grows most effectively in moderate climates. In Meghalaya, French bean is mostly grown in regions of West Khasi hills, East Khasi hills, and Ri-Bhoi district.

“It does not nodulate with native rhizobia *i.e.* nitrogen-fixing bacteria (*Rhizobium phaseoli*) like other leguminous crops, so it requires nitrogen fertilizer as non-leguminous crops. Nitrogen is the most essential nutrient in plant as it is associated with all vital processes. It has more influence on crop growth, production, and quality than any other nutrient” [2]. “Judicious use of N ensures great harvest with better quality. Nitrogen is an essential constituent of protein, chlorophyll present in major portions of plants. It plays most important role in various physiological processes. Imparts dark-green color in plants, promotes growth and development of leaves, stem and other vegetative parts. It increases the uptake of phosphorus, potassium and other nutrients” [3,4]. “Nitrogen deficiency constraints leaf area expansion, enhances leaf senescence inhibits photosynthetic rate in most of the crops and consequently reduces the crop productivity” [5,6]. So, there is a need for application of nitrogenous fertilizers in proper amount for plant growth and development. Keeping this in view the present investigation is taken out find out the effect of basal and split doses of nitrogen on growth and yield of French bean.

2. MATERIALS AND METHODS

The present investigation was carried out at School of Natural Resource Management, College of Post Graduate Studies in Agricultural Sciences, CAU, Umiam, Meghalaya during summer season 2021. The experiment was conducted with four different doses of nitrogen *viz.,* 0, 30, 60 and 90 kg ha^{-1}with two application method *i.e.,* Full basal, 2/3rd as basal+1/3rd as top dressing after one month of sowing (at branching) with a total of 7 treatments in Randomizes Block Design with four replications. The unit plot size was 3 m X 3 m (9m^2). The treatments were T_0: control, T_1: 30 kg N ha^{-1} as basal, T_2: 60 kg N ha^{-1} as basal, T_3: 90 kg N ha^{-1}as basal, T_4: 20 kg N ha^{-1} as basal + 10 kg as top dressing, T_5: 40 kg N as basal + 20 kg as top dressing, T_6: 60 kg N ha^{-1} as basal + 30 kg as top dressing. French bean variety Selection 9 selected as test crop for the experiment. Phosphorus applied in the form of single super phosphate, potassium applied in the form of murate of potash as basal dose and nitrogen is applied in the form of urea as basal doses and top dressing. All other agronomic management practices were followed as per recommendation.

3. RESULTS AND DISCUSSION

3.1 Plant Height

Plant height is an observable parameter that can differentiate with treatment response. The data related to plant height in mentioned in Table 1 revealed that there is an increase in plant height with different growth stages *i.e.,* 20, 40, 60 DAS and at maturity. Significantly highest plant was observed with split application of 90 Kg N ha^{-1} (2/3rd as basal (60 kg N ha^{-1})+ 1/3rd as split(30 kg N ha^{-1})) in all the growth stages. Lowest plant height was observed in control treatments as 11.50 cm at 20 DAS, 28.33 cm at 40 DAS, 32.78 cm at 60 DAS and 33.53 cm at maturity respectively. Where as significantly highest plant height was observed as 14.88 cm at 20 DAS, 36.24 cm at 40 DAS, 37.65 cm at 60 DAS and 39.35 cm at maturity respectively. There is an increase in plant height in different growth stages of frenchbean with increase in nitrogen doses as basal, split and combined application of basal and split respectively. Application of N increases size of cells, meristematic activities and formation and function of protoplasm, which consequently increases crop growth. This could be attributed to the fact that basal application of N supported vegetative growth while split application balanced the vegetative growth [7]. Similar results were obtained by Srinivas and Naik [8] and Chandra et al. [9] in frenchbean.

3.2 Number of Branches Per Plant

The data presented in Table 1 shows that there is an increase in number of branches per plant with advancement of growth stages. Lowest number of branches were observed in control treatment in 20 DAS (1.25), 40 DAS (1.72), 60 DAS (2.12) and at maturity stage (2.59). There is a significant increase in number of branches per plant in fertilized treatments when compared to control treatment. With, increase in nitrogen doses there is a significant increase in number of branches per plant. Significantly highest number of branches were observed application of 90 kg N ha^{-1} as 2.56, 2.96, 3.66, 3.56 at 20, 40, 60 DAS and maturity respectively. There is a significant increase in number of branches per plant with 2/3rd basal+ 1/3rd split application when compared to basal doses at 20, 60 DAS and at maturity. Whereas, they are at par with each other in 40 DAS. Nitrogen enhanced vegetative growth and development of plants which ultimately increased the number of branches per plant [10]. Similar findings were reported by Sanjaichaudhry (2009) and Lad et al*.* [11] in frenchbean.

3.3 Yield Attributes and Yield

The data on grain yield (kg ha^{-1}), stover yield (kg ha^{-1}), Biological yield (kg ha^{-1}), Harvest index (%) and protein yield (kg ha^{-1}) as influenced by doses and split application of N were recorded at harvest and presented in table. And the data on yield attributes of frenchbean viz. No. of pods plant^{-1}, pod length (cm), number of grains pod^{-1}, test weight (g), pod weight (g plant^{-1}), grain weight (g plant^{-1}) and shelling percentage as influenced by doses and split application of N were recorded at harvest and are presented in Tables 2 and 3.

Table 1. Effect of doses and split application of nitrogen on plant height and branches plant^{-1} in frenchbean

	Plant height				**Branches plant^{-1}**			
Treatments	20 DAS	40 DAS	60DAS	Harvest	20 DAS	40 DAS	60 DAS	Harvest
Control vs fertilized								
Control	11.50	28.33	32.78	33.53	1.25	1.72	2.12	2.59
Fertilized	14.35	33.60	37.08	37.85	2.01	2.62	3.17	3.24
S.E. (m)	0.24	0.90	0.67	0.48	0.04	0.08	0.10	0.08
C.D (p=0.05)	0.71	2.59	1.98	1.43	0.11	0.23	0.31	0.23
Doses of N								
30	13.80	30.53	35.29	36.19	1.49	2.37	2.81	2.93
60	14.36	34.03	38.29	38.01	1.98	2.53	3.05	3.23
90	14.88	36.24	37.65	39.35	2.56	2.96	3.66	3.56
S.E. (m)	0.22	0.81	0.62	0.45	0.04	0.07	0.10	0.07
C.D (P=0.05)	0.66	2.40	1.83	1.32	0.11	0.21	0.28	0.21
Split application								
Basal	14.04	33.54	37.36	37.28	1.87	2.57	3.01	3.13
2/3 basal + 1/3 as split	14.65	33.65	36.79	38.42	2.15	2.67	3.34	3.35
S. E. (m)	0.18	0.66	0.50	0.36	0.03	0.06	0.08	0.06
C.D (p=0.05)	0.54	1.96	1.50	1.08	0.09	0.17	0.23	0.18

Table 2. Effect of doses and split application of nitrogen on yield attributeds in frenchbean

Treatments	No. of pods plant^{-1}	Pod length (cm)	No. of grains pod^{-1}	Test weight	Pod weight Plant^{-1}	Grain weight plant^{1}	Shelling %
Control vs Fertilized							
Control	2.75	11.03	4.00	225.80	4.02	0.60	10.05
Fertilized	6.13	13.13	6.92	245.43	8.98	4.65	43.41
S.E. (m) ±	0.22	0.32	0.52	4.82	0.50	0.11	4.06
C.D (*p*=0.05)	0.66	0.96	1.55	14.31	1.47	0.34	12.06
Doses of N							
30	4.89	10.42	4.33	231.83	5.06	2.58	19.93
60	6.00	11.78	6.22	250.39	7.98	2.88	29.28
90	5.44	12.82	7.89	254.06	10.91	6.94	66.55
S.E. (m)	0.21	0.30	0.48	4.46	0.46	0.11	3.76
C.D (*p*=0.05)	0.61	0.89	1.43	13.25	1.36	0.31	11.16
Split application							
Basal	5.92	12.75	6.50	246.79	8.77	4.07	42.01
2/3rd as basal + 1/3rd at branching	6.33	13.32	7.33	244.06	9.19	5.23	44.80
S.E. (m)	0.17	0.24	0.39	3.64	0.37	0.09	3.07
C.D (*p*=0.05)	NS	0.61	NS	NS	NS	0.26	NS

Number of pods per plant and number of seeds per pod increased with increase in nitrogen doses. Lowest number of pods per plant (2.75) and number of seeds per pod (4) were observed in control. Significantly highest number of pods per plant (5.44) and number of seeds per pod (7.89) were observed with application of 90 kg N ha^{-1}. There is significant increase in number of pods per plant (6.13), number of seeds per pod (6.92) in fertilized plot when compared to control. Significant increase was observed in 2/3rd basal dose +1/3rd split application (8.44, 9.78) over basal dose (7.89, 8.67) for number of pods per plant and number of seeds per pod respectively as mentioned in Table 2. Adequate availability of nitrogen at the stage of tissue differentiation from somatic to reproductive phase, leading to enhanced meristematic activity and development of floral primordial is self-explanatory for greater number of flower production with later develop into pods [12]. Similar observations were also recorded by Biswas et al. [13] Lad et al*.* [11].

The data pertaining to seed yield (kg ha^{-1}) presented in Table 3 shows that with increase in nitrogen doses there is an increase in seed yield. Significantly highest seed yield was obtained with application of 90 kg N ha^{-1} as 762.32 kg ha^{-1}. Whereas, lowest seed yield was observed in control as 146.25 kg ha^{-1}. There is significant difference in fertilized treatments (641.39 kg ha^{-1}) when compared to control treatment. Significant difference in seed yield was also observed with 2/3rd basal dose +1/3rd split as 905.72 kg ha^{-1} over basal dose as 804.65 kg ha^{-1}. Manivannan et al*.* [14] the yield and harvest index increased with nutrient levels might be due to the direct role of nitrogen to seed growth and indirectly help in accommodating osmotic imbalances present during final stage of seed filling. Higher seed yield may be due to better expression of growth and yield parameters through higher number of pods per plant, number of seeds per pod and pod length (cm). The increased crop growth might be ensued to yield components and finally the seed yield. Moreover, the split application of nitrogen, if applied at right stage might improve the nitrogen use efficiency besides increased grain yield. The results are in close agreement with those reported by Reddy et al*.* [15] and Shubhashree et al*.* [16] Ali et al*.* [17] the French bean responded good to the increase doses of fertilizers. These increases in the yield component may be the result of better utilization of NPK which resulted in increased biosynthesis of the photosynthates and ultimately the yield. Kakon et al*.* [18] reported that with increase in nitrogen doses there is increase in seed yield of frenchbean. Similar results were also obtained by Basnet et al*.* [19] and Mourya and Kushwah [20].

Protein yield is the product of grain yield and protein content. Relatively higher protein content coupled with significantly high grain yield was the reason for high protein yield with greater N doses and its split application. Chaudhry [21] and Shahid et al*.* [22] also observed similar trend in grain protein yield due to similar reasons [23-26].

Table 3. Effect of doses and split application of nitrogen on yield in frenchbean

Treatments	Biological yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Grain yield (kg ha^{-1})	Harvest index	Protein content in seed (%)	Protein yield (kg ha^{-1})
Control vs Fertilized						
Control	520.9	510.90	191.25	29.16	20.78	39.77
Fertilized	1716.7	1084.31	647.25	37.48	22.17	143.33
S.E. (m) ±	105.4	93.00	19.36	1.93	0.23	4.40
C.D (p=0.05)	313.1	276.33	57.52	5.73	0.69	13.08
Doses of N						
30	1117.5	756.7	405.4	35.23	22.52	91.36
60	1788.6	1109.9	678.8	38.52	21.58	146.23
90	2444.0	1386.4	857.6	38.70	22.42	192.39
S.E. (m) ±	97.5	86.10	17.92	1.78	0.22	4.08
C.D (p=0.05)	289.8	255.83	53.25	NS	NS	12.11
Split application						
Basal	1566.3	979.78	615.20	38.34	22.12	136.39
2/3rd as basal + 1/3rd at branching	1868.13	1188.83	679.29	36.63	22.23	150.27
S.E. (m)±	79.6	70.30	14.63	1.46	0.18	3.33
C.D (*p*=0.05)	236.6	208.88	43.48	NS	NS	9.89

4. CONCLUSION

From the present investigation it is concluded that application of 90 kg N ha^{-1} resulted in better growth, yield and yield attributes. Application of 2/3rd basal dose and 1/3rd split dose of nitrogen fertilizer was superior over basal dose nitrogen dose.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
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https://www.sdiarticle5.com/review-history/123926