Original Research Article

Influence of nitrogen and boron on growth and yield of French bean

ABSTRACT

A field experiment was conducted at Crop Research Farm, Department of Agronomy, Naini Agriculture Institute, Sam Higginbottom Institute of Agriculture, Technology and Sciences, Prayagraj, UP, during the Rabi season of 2022 on sandy loam soil. The experiment consisted of three levels of nitrogen viz., (80 kg/ha, 100 kg/ha and 120 kg/ha) and 3 levels of boron (1 kg/ha, 1.5 kg/ha and 2 kg/ha) including control i.e., blanket application of 120-60-50 kg/ha of NPK (farmer's practice) which were replicated thrice. The results of the experiment revealed that the application of 120 kg/ha of nitrogen along with 1.5 kg/ha of boron significantly increased the growth parameters *viz.*, plant height (23.68 cm), dry weight (9.633 g/plant), and yield parameters *viz.*, pods per plant (13.93), seeds per pod (4.84), seed yield (2.43 t/ha) and stover yield (3 t/ha). This treatment also showed its positive effect on economics viz., gross returns (1,21,500 INR/ha), net returns (84,655 INR/ha), B:C (2.30).

Keywords: Boron, French bean, Growth parameters, Nitrogen, Seed yield

INTRODUCTION

French bean (*Phaseolus vulgaris* L.) belongs to family Leguminosae native to Central and South America and is one of the high potential pulse crops. The crop is able to grown in all types of soils ranging from sandy loam to clay soils but cannot withstand under waterlogging conditions. The highest yield is obtained in soils with a pH range from 5.3 - 6.0. It is known by various names *viz.*, rajma, rajmash, field bean, haricot bean, kidney bean, pole bean, snap bean etc. French bean is valued for its protein rich (23%) seeds. It also contains K, Ca, Mg, Fe, P, vitamins A, B, D, starch and no fat (Usha *et al*. 2019). In India, it is cultivated over an area of 297 thousand hectares with a production of 2.74 million tonnes (Ministry of Agriculture and Farmers Welfare, Govt. of India).

Nitrogen is an essential macronutrient involved in a wide range of plant process from plant growth to protein content of grains, it is a key component of amino acids, which forms the building blocks of plant proteins and enzymes that helps in vegetative growth and produces quality foliage by promoting carbohydrate synthesis and encouraging structure. Unlike in other pulses, French bean is poor in biological nitrogen fixation as it lacks nodulation due to absence of NOD gene regulator even with native Rhizobia and commercially produced cultures. Hence, the nitrogen requirement for French bean is different when compared to other pulse crops and application of nitrogen through fertilizers is crucial for exploiting its yield potential (jan *et al*. 2017). Crop fertilized with optimum nitrogen can utilize more phosphorous, potassium and calcium, it is due to the fact that nitrogen fertilization increases the cation exchange capacity of plant roots and therefore, other nutrient ions are absorbed in larger amounts.

Among micronutrients boron deficiency is found to affect growth and yield parameters and is one of the major constraints that limits the production of pulse crops. Boron application has a positive influence on growth, yield and quality of the crop (Sharma *et al*., 2013). Moreover, the crop is not only sensitive to boron deficiency, but also to excess boron can lead to toxicity, therefore, it is desirable to obtain information on effects of residual boron on succeeding crops that may be sensitive to high levels of boron in soil. It is an essential micronutrient required for normal growth of the plants, differentiation of tissues besides being helpful in reducing sterility and malformation of reproductive organs. It has been found to play a key role in reproductive processes affecting anther development, pollen germination and pollen tube growth (Ganie *et al*. 2014).

MATERIALS AND METHODS

The experiment was carried out during *rabi* season of 2022 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj. The soil was sandy loam in texture, medium in available nitrogen (283.93 kg/ha), available phosphorous (18.3 kg/ha) available potassium (223.5 kg/ha). The experiment was laid out in Randomized Block Design along with 10 treatment combinations and replicated thrice. Treatments were randomly arranged in each replication, divided into 30 plots. The treatments involve 3 levels of Nitrogen (80, 100 and 120 kg/ha) and 3 levels of Boron (1, 1.5 and 2 kg/ha). The treatment combinations are as follows, T_1 – 80 kg/ha nitrogen and 1 kg/ha boron, T_2 – 80 kg/ha nitrogen and 1.5 kg/ha boron, T_3 – 80 kg/ha nitrogen and 2 kg/h boron, T_4 – 100 kg/ha nitrogen and 1 kg/ha boron, T_5 – 100 kg/ha nitrogen and 1.5 kg/ha boron, T_6 – 100 kg/ha nitrogen and 2 kg/ha boron, T_7 – 120 kg/ha nitrogen and 1 kg/ha boron, T_8 – 120 kg/ha nitrogen and 1.5 kg/ha boron, T_9 – 120 kg/ha nitrogen and 2 kg/ha boron and T_{10} – control 120-6-50 NPK/ha. The experimental field was ploughed thoroughly to obtain fine seed bed. The fertilizers were applied as per treatment combination as basal dose, nitrogen was given in split dose. The French bean seeds were sown at spacing of 45 cm x 10 cm with the seed rate of 50 – 75 kg/ha, gap filling and thinning was carried out during 10 DAS and 15 DAS, respectively in order to maintain optimum plant population. The growth parameters like plant height (cm), dry weight (g/plant) were recorded at different growth stages of the plant. The yield contributing characters such as number of pods per plant, number of seeds per pod, seed yield (t/ha) and stover yield (t/ha) were recorded at the time of harvest and averages were calculated and the data was statistically analyzed using ANOVA technique (Gomez and Gomez 1984).

RESULTS AND DISCUSSIONS

Growth attributes

The observations related to growth parameters were Presented in Table 1. Results revealed that significantly higher plant height (23.68 cm) and dry weight (9.63 g/plant) were recorded with the application of 120 kg/ha nitrogen and 1.5 kg/ha boron. The increase in plant height may be due to the fact that nitrogen fertilization increases the cation exchange capacity of plant roots and therefore, other nutrient ions are absorbed in larger amounts, while boron aids in improved photosynthesis and nutrient uptake by plants. The results are similar with (Ghosh *et al*., 2014) and (Hegade *et al*., 2014). Similarly increase in dry weight is due to, positive relation of dry matter production with photosynthesis, increased application of nitrogen and boron fertilizers increases the rate of photosynthesis, cell differentiation and development, translocation of photosynthates from source to sink in later stages of growth and its involvement in protein synthesis thereby increasing the dry matter production in plants. The results are in conformity with (Basnet *et al*., 2022).

Yield attributes and yield

The observation related to yield attributes were presented in Table 2. The results revealed that significantly higher pods per plant (13.93), seeds per pod (4.84), seed yield (2.43 t/ha) and stover yield (3 t/ha) were recorded with the application of 120 kg/ha nitrogen and 1.5 kg/ha boron. The increase in pods/plant and seeds/pod might be due to availability of sufficient nutrients to plants during pod formation and filling stage, and also boron application has affected the reproductive process by producing maximum flowers and minimizing the flower drop during frost. Seed yield (t/ha) and stover yield (t/ha) also increases significantly with an increase in nitrogen and boron levels, the production of a higher number of effective pods and seeds/pod, resultd in increased seed yield of the crop. The similar results were reported by (Awene *et al*., 2022) and (Uddin *et al*., 2020).

Economics

The observation related to economics were presented in Table 3. The maximum gross return (1,21,500 ₹ /ha), net return (84,655 ₹ /ha) and benefit cost ratio (2.30) were recorded with application of 120 kg/ha nitrogen and 1.5 kg/ha boron, while the lowest gross return (76,500 ₹ /ha), net return (40,747 ₹ /ha) and benefit cost ratio (1.14) were recorded with the application of 80 kg/ha nitrogen and 1 kg/ha boron.

CONCLUSION

From the experimental results, it can be concluded that, application of 120 kg/ha nitrogen and 1.5 kg/ha boron in French bean was found to be more beneficial in terms of growth and yield. This treatment also fetched the maximum gross return, net return, and benefit-cost ratio as compared to other treatments.

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Table 1. Influence of nitrogen and boron on growth of French bean

Sl. No.	Treatments	Plant height (cm)	Dry weight (g/plant)
1.	Nitrogen 80 kg/ha + Boron1 kg/ha	16.90	2.433
2.	Nitrogen 80 kg/ha + Boron1.5 kg/ha	18.23	3.767
3.	Nitrogen 80 kg/ha + Boron2 kg/ha	19.71	4.267
4.	Nitrogen 100 kg/ha + Boron1 kg/ha	17.16	4.333
5.	Nitrogen 100 kg/ha + Boron1.5 kg/ha	16.77	4.433
6.	Nitrogen 100 kg/ha + Boron2 kg/ha	18.69	5.067
7.	Nitrogen 120 kg/ha + Boron1 kg/ha	20.20	7.533
8.	Nitrogen 120 kg/ha + Boron1.5 kg/ha	23.68	9.633
9.	Nitrogen 120 kg/ha + Boron2 kg/ha	18.45	6.800
10.	120-60-50 kg NPK/ha (control)	17.85	7.367
	SEm(±)	1.17	0.76
	CD (P=0.05)	3.48	1.59

Table 2. Influence of nitrogen and boron on yield attributes and yield of French bean

Sl.No.	Treatments	Pods/plant	Seeds/pod	Seed yield (t/ha)	Stover yield (t/ha)
1.	Nitrogen 80 kg/ha + Boron1 kg/ha	11.33	4.32	1.53	2.08
2.	Nitrogen 80 kg/ha + Boron1.5 kg/ha	11.60	4.41	1.63	2.25
3.	Nitrogen 80 kg/ha + Boron2 kg/ha	11.87	4.47	1.70	2.36
4.	Nitrogen 100 kg/ha + Boron1 kg/ha	11.33	4.45	1.61	2.11
5.	Nitrogen 100 kg/ha + Boron1.5 kg/ha	12.53	4.55	1.89	2.57
6.	Nitrogen 100 kg/ha + Boron2 kg/ha	12.60	4.56	1.94	2.64
7.	Nitrogen 120 kg/ha + Boron1 kg/ha	12.80	4.77	2.13	2.72
8.	Nitrogen 120 kg/ha + Boron1.5 kg/ha	13.93	4.84	2.43	3.00
9.	Nitrogen 120 kg/ha + Boron2 kg/ha	12.27	4.55	1.84	2.48
10.	120-60-50 kg NPK/ha (control)	12.73	4.65	1.99	2.61
	SEm(±)	0.40	0.04	0.11	0.11
	CD (P=0.05)	1.19	0.12	0.32	0.33

Table 3. Influence of nitrogen and boron on economics of French bean

Sl. No.	Treatments	Gross returns (INR/ha)	Net returns (INR/ha)	B:C
1.	Nitrogen 80 kg/ha + Boron1 kg/ha	76500	40747	1.14
2.	Nitrogen 80 kg/ha + Boron1.5 kg/ha	81333.5	44955.5	1.24
3.	Nitrogen 80 kg/ha + Boron2 kg/ha	84833.5	47830.5	1.29
4.	Nitrogen 100 kg/ha + Boron1 kg/ha	80333.5	44345.5	1.23
5.	Nitrogen 100 kg/ha + Boron1.5 kg/ha	94500	57887	1.58
6.	Nitrogen 100 kg/ha + Boron2 kg/ha	97166.5	59928.5	1.61
7.	Nitrogen 120 kg/ha + Boron1 kg/ha	106500	70280	1.94
8.	Nitrogen 120 kg/ha + Boron1.5 kg/ha	121500	84655	2.30
9.	Nitrogen 120 kg/ha + Boron2 kg/ha	92166.5	54696.5	1.46
10.	120-60-50 kg NPK/ha (control)	99500	64530	1.85

* Data was not subjected to statistical analysis.