



Effect of Foliar Sprays of Boron on Quality and Nutrient Uptake of French Bean (*Phaseolus vulgaris* L.) in Entisol

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Authors' contributions

This work was carried out in collaboration among all authors. Author PAM designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors ADJ, PBJ and BDT managed the analyses of the study. Author DDS managed the literature searches. All authors read and approved the final manuscript.

Article Information

Editor(s):

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Complete Peer review History: <http://www.sdiarticle4.com/review-history/60556>

Original Research Article

Received 18 July 2020
Accepted 23 September 2020
Published 07 October 2020

ABSTRACT

The pot culture experiment was conducted to study the effect of foliar application of boron through boric acid @ 0.2, 0.4, 0.6 and 0.8 percent and soil application of borax @ 2.5 kg ha⁻¹ and 5.0 kg ha⁻¹ on growth and yield of French bean Cv. *Phule Suyash*. In Entisol at Division of Soil Science and Agricultural Chemistry, College of Agriculture, Pune, during *Rabi* 2017-2018. The experimental soil was deficient in boron (0.35 mg kg⁻¹). There were eight treatments replicated thrice in a completely randomized design. Application of GRDF (50:110:110 N, P₂O₅, K₂O kg ha⁻¹) along with two foliar sprays of boric acid @ 0.6 per cent at 25 and 55 DAS recorded significantly higher uptake of nitrogen (3.58 g pot⁻¹), phosphorus (0.23 g pot⁻¹), K (1.84 g pot⁻¹) and Boron (39.91 mg pot⁻¹). Significantly higher protein (22.65%) content in french bean was recorded with the application of

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GRDF along with soil application of borax @ 5 kg ha⁻¹ at the time of sowing and it was closely followed by GRDF + Two foliar sprays of boric acid each @ 0.6 per cent at 25 and 55 DAS (22.50%).

Keywords: French bean; boron; nutrient uptake; entisol.

1. INTRODUCTION

Most of the soils (fine as well as coarse textured) are considered to be low in available boron as it has been reported that < 1 mg kg⁻¹ B is not sufficient for optimum plant growth [1]. Boron has been found to play a key role in reproductive processes affecting another development, pollen germination and pollen tube growth [2].

It is also recognized as an essential micronutrient for vascular plants and is believed to be involved in nucleic acid metabolism, cell division, sugar biosynthesis and translocation, active nutrient absorption, regulation rate of photosynthesis and nodulation process. Boron deficiency is associated with sterility and malformation of reproductive organs. Alos sexual reproduction has often been found to be more sensitive to inadequate boron supply than vegetative growth and seed yields can be considerably reduced without there being any effect on growth [3].

Boron is a trace element that can be applied in soil as well as foliar. It is many times observed that foliar applied boron causes increased in yield more than soil applied boron because boron is required more at reproductive stage and foliar applied is instantly present for plant in compare to soil applied boron. Foliar nutrition is designed to eliminate the problems like fixation and immobilization of nutrients. Hence foliar nutrition is recognized as an important method of fertilization in modern agriculture. This method provides utilization of nutrients more efficiency and for correcting the deficiencies rapidly [4].

French bean (*Phaseolus vulgaris* L.) is one of the most important leguminous vegetable crops in India. It is also known as rajmah or rajma (Hindi) or haricot bean or kidney bean or common bean or snap bean and navy bean. French bean is valued for its protein (23%) rich seeds. Seeds are also rich in calcium, phosphorus and iron. The fresh pods are used as vegetable. As a nutritious vegetable, it contains calcium (50 mg), phosphorus (28 mg), iron (1.7 mg), carotene (132 mg), thiamine(0.08 mg), riboflavin (0.06 mg)

and vitamin C (24.0 mg) in each 100 g of edible pods [5]. In Western World (USA, Western Europe), both the fresh pods and processed pods consumption is quite. The countries producing substantial dry beans are Brazil, Mexico, Argentina, Chile, Central America and Latin America. Thus, there is paucity of information on the foliar sprays of boron, the present investigation was therefore undertaken to study the response of the foliar sprays of boron through various levels in pot culture.

To meet the dietary need for common man, to avoid malnutrition, deficiency disease and to relive over stress on cereals, there is a greater need to enhance vegetable production like Rajma [6].

2. MATERIALS AND METHODS

The pot culture experiment was conducted to study the effect of foliar application of boron through boric acid @ 0.2, 0.4, 0.6 and 0.8 percent and soil application of borax @ 2.5 kg ha⁻¹ and 5.0 kg ha⁻¹ on growth and yield of French bean Cv. *Phule Suyash* in Entisol in during *Rabi* 2017 on sandy loam soil. Earthen pots of 10 kg capacity having size of 30×28 cm were used for experiment. Due care was taken to ensure enough aeration and no water stagnation. The foliar application of boric acid at the rate of 0.2 %, 0.4%, 0.6%, 0.8% to treatment T₃, T₄, T₅ and T₆ was given at 25 and 55 days after sowing. Soil application of borax for T₇, T₈ was done at the time of sowing. Treatment detail are given in Table 1.

The experiment was laid out in a CRD with eight treatments replicated thrice. Soil sample was collected before sowing of french bean and analyzed as per standard methods [7]. The experimental soil was sandy loam in texture had a pH (7.58) slightly alkaline in reaction, low in soluble salts (EC 0.14dS m⁻¹), medium in organic carbon (0.47%), low in available N (150.5 kg ha⁻¹), medium in available P (23.9 kg ha⁻¹) and low in available K (176.76 kg ha⁻¹). The soil was deficient in boron content (0.35 mg kg⁻¹).

Table 1. Treatments detail

Treatment No.	Particulars
T ₁	Absolute Control
T ₂	GRDF (50:110:110 N:P ₂ O ₅ :K ₂ O kg ha ⁻¹ + 10 t FYM ha ⁻¹)
T ₃	GRDF + Two foliar sprays of boric acid each @ 0.2% at 25 and 55 DAS
T ₄	GRDF + Two foliar sprays of boric acid each @ 0.4% at 25 and 55 DAS
T ₅	GRDF + Two foliar sprays of boric acid each @ 0.6% at 25 and 55 DAS
T ₆	GRDF + Two foliar sprays of boric acid each @ 0.8% at 25 and 55 DAS
T ₇	GRDF + Soil application of borax @ 2.5 kg ha ⁻¹ at the time of sowing.
T ₈	GRDF + Soil application of borax @ 5.0 kg ha ⁻¹ at the time of sowing.

Note: 1. Foliar sprays at initiation of flowering at 25 days after sowing; 2. Foliar sprays at pod development stage at 55 days after sowing

The data on growth parameters, yield contributing characters and green pod yield were recorded at harvest stage. The pods and straw samples of french bean were collected at harvest. The dust and soil particles were removed from straw samples. These straw samples were first washed with deionized water and then with distilled water. It was then dried in diffuse sunlight under laboratory condition then in oven at 70°C temperature till constant weight. The dried plant parts were ground to fine powder. This fine powder was again dried in oven at 60°C for a 24 hour and stored in properly till the samples were used for chemical analysis. The oven dried samples were digested with 1:1 H₂SO₄:H₂O₂ acid digestion methods for analysis of N, P, K and Boron. The data on various parameters recorded during the period of investigation were tabulated and statistically analyzed [8].

2.1 Protein Content

The per cent crude protein content in seed was calculated by multiplying per cent nitrogen content of seed with a factor 6.25 [9].

2.2 Nutrient Uptake

Total N,P,K, and B indicate Nutrient concentration in plant sample and this are analysed by standard methods. The uptake of N, P, K and B at harvest in seed and straw was estimated by using formulae given as.

$$\text{Nutrient uptake} = \text{concentration of nutrients} \times \text{dry matter yield}/100$$

3. RESULTS AND DISCUSSION QUALITY PARAMETERS

3.1 Protein Content

Data regarding protein content (%) in pods of french bean as influenced by different treatments

are presented in Table 2. Significantly higher protein (22.65%) content in french bean was recorded with the application of GRDF along with soil application of borax @ 5 kg ha⁻¹ at the time of sowing and closely followed by GRDF + two foliar sprays of boric acid each @ 0.6 per cent at 25 and 55 DAS (22.50%). Higher protein content was recorded might be due to boron regulate synthesis of amino acid, protein and also take part in sugar translocation and carbohydrate metabolism. The finding are in close conformity with those of [10] in black gram, [11] in cowpea and [12] in pea seeds.

3.2 Nutrient Uptake

The data pertaining to total uptake of nitrogen, phosphorus, potassium and boron influenced by different treatments are presented in Table 3.

It's clearly indicated "A significantly increased in the uptake of nitrogen was observed after to boron application". Significantly higher nitrogen uptake was in T₅ (3.58 g pot⁻¹) which was at par with T₄ (2.09 g pot⁻¹), T₆ (2.76 g pot⁻¹) and T₇ (2.07 g pot⁻¹).

It's clearly indicated "A significantly increased in the uptake of phosphorus was observed after to boron application". Significantly higher phosphorus uptake was in T₅ (0.23 g pot⁻¹) which was at par with T₄ (0.13 g pot⁻¹), T₆ (0.16 g pot⁻¹) and T₇ (0.13 g pot⁻¹).

It's clearly indicated "A significantly increased in the uptake of Potassium was observed after to boron application". Significantly higher potassium uptake was in T₅ (1.84 g pot⁻¹) However, GRDF (0.65 g pot⁻¹) the application of boric acid @ 0.2% (0.81 g pot⁻¹), 0.4 % (0.89 g pot⁻¹), 0.8%(1.23g pot⁻¹), borax @ 2.5 kg ha⁻¹ (0.88 g pot⁻¹) and 5.0 kg ha⁻¹ (0.59 g pot⁻¹) were significantly superior in respect to boron uptake over control.

Table 2. Effect of boron application on protein content of French bean

Treatment No.	Treatments	Protein content (%)
T ₁	Absolute Control	19.54
T ₂	GRDF (50:110:110 N:P ₂ O ₅ :K ₂ O kg ha ⁻¹ + 10 t FYM ha ⁻¹)	22.06
T ₃	GRDF + Two foliar sprays of boric acid each @ 0.2% at 25 and 55 DAS	21.96
T ₄	GRDF + Two foliar sprays of boric acid each @ 0.4% at 25 and 55 DAS	21.88
T ₅	GRDF + Two foliar sprays of boric acid each @ 0.6% at 25 and 55 DAS	22.50
T ₆	GRDF + Two foliar sprays of boric acid each @ 0.8% at 25 and 55 DAS	22.38
T ₇	GRDF + Soil application of borax @ 2.5kg ha ⁻¹ at the time of sowing.	22.42
T ₈	GRDF + Soil application of borax @ 5.0 kg ha ⁻¹ at the time of sowing.	22.65
	SE (±)	0.38
	CD (0.05 %)	1.14

Table 3. Effect of boron application on total uptake of nitrogen, phosphorus, potassium and boron French bean

Treatment No.	Treatments	Nutrient uptake (g pot ⁻¹)			B uptake (mg pot ⁻¹)
		N	P	K	
T ₁	Absolute Control	0.76	0.05	0.32	3.59
T ₂	GRDF(50:110:110 N:P ₂ O ₅ :K ₂ O kg ha ⁻¹ + 10 t FYM ha ⁻¹)	1.50	0.10	0.65	8.61
T ₃	GRDF + Two foliar sprays of boric acid each @ 0.2% at 25 and 55 DAS	1.83	0.12	0.81	15.18
T ₄	GRDF + Two foliar sprays of boric acid each @ 0.4% at 25 and 55 DAS	2.09	0.13	0.89	20.92
T ₅	GRDF + Two foliar sprays of boric acid each @ 0.6% at 25 and 55 DAS	3.58	0.23	1.84	39.91
T ₆	GRDF + Two foliar sprays of boric acid each @ 0.8% at 25 and 55 DAS	2.76	0.16	1.23	35.66
T ₇	GRDF + Soil application of borax @ 2.5kg ha ⁻¹ at the time of sowing.	2.07	0.13	0.88	32.89
T ₈	GRDF + Soil application of borax @ 5.0 kg ha ⁻¹ at the time of sowing.	1.21	0.12	0.59	28.09
	SE (±)	0.15	0.03	0.06	2.18
	CD (0.05 %)	0.44	0.10	0.18	6.58

It's clearly indicated "A significantly increased in the uptake of boron was observed after to boron application". Significantly higher boron uptake was in T₅ (39.91 mg pot⁻¹) which was at par with T₆ (35.66 mg pot⁻¹). However, the application of boric acid @ 0.4% (20.92 mg pot⁻¹), borax @ 2.5 kg ha⁻¹(32.89 mg pot⁻¹) and 5.0 kg ha⁻¹ (28.09 mg pot⁻¹) were significantly superior in respect to boron uptake as compared to T₂ GRDF (8.61 mg pot⁻¹).

Increase in concentration of N, P, K, and B indicate directly its uptake is increased. The increase in nutrient uptake (N, P, K and B) due to B application could be attributed to improved nutritional environment in the rhizosphere as well as in plant system. Moreover, the uptake followed yield pattern, as yield was higher, so was the uptake.

Similar findings have been reported in french bean and chickpea [13,14].

4. CONCLUSION

The results of the present investigation concluded that application of either T₈ (GRDF + Soil application of borax @ 5 kg ha⁻¹ at time of sowing) or T₅ (GRDF + Two foliar sprays of boric acid each @ 0.6 per cent at 25 and 55 DAS) found to be beneficial for quality and nutrient uptake of french bean.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:

The peer review history for this paper can be accessed here:
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