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PA Mahadule
M.Sc. Student, Division of Soil Science and Agricultural Chemistry, College of Agriculture, Pune, Maharashtra, India

AD Jagdhani
Assistant Professor, Division of Soil Science and Agricultural Chemistry, College of Agriculture, Pune, Maharashtra, India

PB Jagtap
Associate Professor, Division of Soil Science and Agricultural Chemistry, College of Agriculture, Pune, Maharashtra, India

BD Tamboli
Professor, Division of Soil Science and Agricultural Chemistry, College of Agriculture, Pune, Maharashtra, India

Mangal Kadam
Assistant Professor, Division of Soil Science and Agricultural Chemistry, College of Agriculture, Pune, Maharashtra, India

Correspondence
PA Mahadule
M.Sc. Student, Division of Soil Science and Agricultural Chemistry, College of Agriculture, Pune, Maharashtra, India

Effect of foliar sprays of boron on growth and yield of French bean (*Phaseolus vulgaris* L.) in Entisol

PA Mahadule, AD Jagdhani, PB Jagtap, BD Tamboli and Mangal Kadam

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 per cent 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 completely randomized design. The foliar application of boron @ 0.6 per cent through boric acid at an interval of 25 and 55 days after sowing was found to be increased number of branches plant significantly over general recommend dose of fertilizers. The soil application of 5.0 kg ha^{-1} borax at the time of sowing was found to Required less days for 50 per cent floweringas compared with general recommend dose (GRD). The foliar application of boron with 0.6 per cent boric acid at 25 and 55 days after sowing increased the number of pods per plant, number of grains pod, straw yield and 100 grain weight and yield of French bean.

Keywords: French bean, boron, yield, Entisol

Introduction
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 100g of edible pods (Chadha, 2001). In Western World (USA, Western Europe), both the fresh pods and processed pods consumption is quite substantial. The countries producing substantial dry beans are Brazil, Mexico, Argentina, Chile, Central America and Latin America.

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. (Palaniappan *et al.*1999) [12].

Boron has been found to play a key role in reproductive processes affecting anther development, pollen germination and pollen tube growth (Loomis and Durst, 1992).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. Dell and Huang (1997) [4] reported that 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.

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.

Material and Methods
The pot culture experiment was conducted to study the effect of foliar application of boron

through boric acid @ 0.2, 0.4, 0.6and 0.8 per cent 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. 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 (Jackson, 1973). The experimental soil was sandy loam in texture had a pH (7.58) slightly alkaline in reaction, low in soluble salts (EC 0.14 dS 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 (0.35 mg kg^{-1}) content. The data on growth parameters, yield contributing characters and green pod yield were recorded at harvest stage. The data on various parameters recorded during the period of investigation were tabulated and statistically analyzed (Panse and Sukhatme, 1967) [14].

Results and Discussion

Growth parameters

The data regarding growth parameters as influenced by various level of boron are presented in table 1. The data clearly indicated that there was significant influence of boron application on growth parameter of french bean

Days to 50% Flowering

There was significant difference for days to 50% flowering due to boron application. The soil application of borax @ 5 kg ha^{-1} at the time of sowing took significantly less days (32.67) for 50% flowering over rest of treatments except T_5 (33) and T_7 (33.33). It is indicated that boron application helped for early flowering to french bean.

Plant Height

The data showed that there was no significant influence of boron application on plant height of French bean.

Number of Branches Perplant

The data indicated that the application of boron either through foliar sprays or soil application could significant increase in number of branches to french bean. The treatment two foliar sprays of boric acid @ 0.4% and 0.6% registered significantly higher number of branches (8.0) which was at par with T_6 (7.33), T_7 (6.67) and T_8 (7.67). This might be due to quick availability of boron to crop during the entire growing season. The boron plays an important role in tissue differentiation and carbohydrate metabolism. It is also a constituent of cell membrane and essential for cell division, maintenance of conducting tissue with regulatory effect on other element. The similar results were shown by Islam *et al.* (2018) and Rahman *et al.* (2013) in french bean.

Table 1: Effect of boron application on growth parameters of French bean

Treat-No.	Treatments	Days to 50 % flowering	Plant height (cm)	Number of branches per plant
T_1	Absolute Control	35.67	31.00	5.00
T_2	GRDF(50:110:110N:P_2O_5:K_2Okg ha^{-1} + 10 t FYM ha^{-1})	35.33	35.50	6.00
T_3	GRDF + Two foliar sprays of boric acid each @ 0.2% at 25 and 55 DAS	34.00	35.50	6.00
T_4	GRDF + Two foliar sprays of boric acid each @ 0.4% at 25 and 55 DAS	33.67	36.50	8.00
T_5	GRDF + Two foliar sprays of boric acid each @ 0.6% at 25 and 55 DAS	33.00	37.50	8.00
T_6	GRDF + Two foliar sprays of boric acid each @ 0.8% at 25 and 55 DAS	33.67	36.50	7.33
T_7	GRDF + Soil application of borax @ 2.5kg ha^{-1} at the time of sowing.	33.33	39.00	6.67
T_8	GRDF + Soil application of borax @ 5.0 kg ha^{-1} at the time of sowing.	32.67	39.00	7.67
	SE (±)	0.56	25.65	0.53
	CD (0.05 %)	1.73	NS	1.61

Yield contributing parameters

The data pertaining to the yield parameters of french bean as influenced by different treatments are presented in table 2. The data showed that there was significant influence of boron application on yield parameters of french bean.

Number of Pod Perplant

The application of boron showed promises for increasing number of pods per plant. Among the various treatments, the foliar application of boric acid @ 0.6 percent registered significantly higher number of pods (19.33) which was at par with two foliar sprays of boric acid @ 0.8% (17.33). In general, there was significant increased in number of pods per plant due to boron application. This is might be due to the boron which helps in the formation of flower and pollen grain formation. Boron treatment might have played a critical role in reducing the flower and pod drop presumably by preventing abscission layer formation. The similar results were reported by Kaisher *et al.* (2010) [8] and Padbhushan and Kumar (2014) [11] in greengram.

Number of Grain Per Pod

There was significant increase in number of grains per pod due to boron application to French bean as compared with T_2 – GRDF with no boron application and T_1 i.e. absolute control. It was noticed that two foliar sprays of 0.6% boric acid registered significantly higher number of grains (5.33) which was at par with T_4 (4.33), T_6 (4.33) and T_7 (4.33).

The improvement was might be due to increase in germination percentage of seed inside the pod and may be due to boron makes stigma receptive and sticky and making pollen grain fertile and enhanced the pollination. Thus, increased the fruit setting reduces the sterility of flower and this number of grain per pod increased. The similar results were reported by Kaisher *et al.* (2010) [8], Zaman *et al.* (1996) and Padbhushan and Kumar (2014) [11] in greengram.

100 Grain weight

Among different treatments the soil application of borax @ 2.5 kg ha^{-1} at the time of sowing registered significantly

higher 100 grain weight (45.66g). However, this treatment was at par with T_5 (45.33g) and T_6 (44.66g).

This improvement in test weight of green gram may be due to boron, which affects cell division, carbohydrate metabolism, sugar and starch formation, which increased the size and weight of grain. The similar results were reported by Padbhushan and Kumar (2014) [11] in greengram.

Green Pod Yield Per Pot

The data showed that the application of boron either through foliar sprays or through soil showed promises. The boron application could increase pod yield of French bean compared with no application of boron to french bean. The application of 0.6% boric acid increased green pod yield (301.33 g). It was interesting to note that boron application at different concentrations and either foliar or through soil recorded at par green pod yield with T_6 treatment. The grain yield increases from 197.33 g in GRDF with no application of boron to 301.33 g.

Improvement in yield might be due to B application which attributed to fulfilment of crop demand by higher assimilation and translocation of photosynthates from leaves to seeds and with increasing boron, the process of tissue differentiation from somatic to reproductive, meristematic activity and development of floral primordial might have increased resulting in more flowers and higher seed yield. The similar results were reported by Kaisher *et al.* (2010) [8], Zaman *et al.* (1996) in green gram.

Table 2: Effect of boron application on yield parameters of French bean

Treatment No.	Treatments	No of pods per plant	No of grains per pod	100 grains weight (g)	Green pod yield per pot (g)	Straw yield per pot (g)
T_1	Absolute Control	8.33	2.67	39.67	90.67	8.91
T_2	GRDF(50:110:110 N:P_2O_5:K_2O kg ha^{-1} + 10 t FYM ha^{-1})	13.33	3.67	42.00	197.33	18.80
T_3	GRDF + Two foliar sprays of boric acid each @ 0.2% at25 and 55 DAS	15.67	4.00	43.67	250.66	24.36
T_4	GRDF + Two foliar sprays of boric acid each @ 0.4% at 25 and 55 DAS	16.00	4.33	44.00	278.66	26.23
T_5	GRDF + Two foliar sprays of boric acid each @ 0.6% at 25 and 55 DAS	19.33	5.33	45.33	301.33	30.20
T_6	GRDF + Two foliar sprays of boric acid each @ 0.8% at 25 and 55 DAS	17.33	4.33	44.66	293.12	25.23
T_7	GRDF + Soil application of borax @ 2.5kg ha^{-1} at the time of sowing.	15.67	4.33	45.66	272.00	25.46
T_8	GRDF + Soil application of borax @ 5.0 kg ha^{-1} at the time of sowing.	15.43	4.00	44.00	265.33	24.53
	SE (±)	0.66	0.33	0.68	28.39	1.36
	CD (0.05 %)	2.02	1.02	2.09	86.96	4.18

Straw Yield Per Pot

The data showed that significantly higher straw yield was obtained in treatment T_5, two foliar sprays of boric acid @0.6% (30.20 g pot^{-1}) which was at par with T_4 (26.23 g pot^{-1}).

The improvement in dry matter yield can be attributed to the role of B in stabilizing certain constituent of cell wall and plasma membrane, enhancement of cell division, increased net photosynthesis, tissue differentiation and metabolism of nucleic acids, carbohydrates, proteins, auxins and phenols. The similar results were reported by Kaisher *et al.* (2010) [8] and Padbhushan and Kumar (2014) [11] in greengram.

Conclusion

The result of present investigation concluded that application of either T_8 (GRDF + Soil application of borax @ 5 kg ha^{-1} at time of sowing) or T_5 (GRDF + Two foliar sprays of boric acid each @ 0.6 per cent at 25 and 55 DAS) found to be beneficial for growth and yield of french bean.

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