



# Response of Sulphur and Iron Application on Growth and Yield of French Bean

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## Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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## 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 *Rabi* season 2022 on sandy loam soil. The experiment consists of three levels of Sulphur viz., 15 kg ha<sup>-1</sup>, 30 kg/ha<sup>-1</sup>, 45 kg/ha<sup>-1</sup> and 3 levels of foliar spray of iron viz., 0.25 % at 20 DAS, 0.50 % at 20 DAS and 30 DAS, 0.75 % at 30 DAS and 40 DAS and control *i.e.*, blanket application of 120-60-50 kg/ha<sup>-1</sup> of NPK (farmer's practice), which were replicated thrice. The variety Arka Komal of French bean was sown in November 5th 2022. The results of the

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experiment revealed that the application of 45 kg/ha<sup>-1</sup> of Sulphur along with 0.5 % of iron at 20 and 30 DAS significantly increased the growth parameters viz., plant height (46.43 cm), plant dry weight (27.21 g/plant) and yield parameters viz., pods/plant (16.67), seeds/pod (5.67), seed index (43.65 g), seed yield (1.88 t/ha), stover yield (5.39 t/ha).

**Keywords:** French bean; growth parameters; iron; sulphur; yield attributes.

## 1. INTRODUCTION

“French bean (*Phaseolus vulgaris* L.) belongs to the family Leguminosae occupies a premier place among grain legumes in the World wide. French bean is quite nutritious and a potential source of protein, carbohydrates, and minerals. It is an excellent crop being grown for pods as well as for seeds. French bean is one of the most important pulse in the country including North East India” [1]. “Globally, French bean is cultivated on about 28 m/ha, producing 19 million tonnes. French bean is highly sensitive to moisture stress and a slight stress may result in yield reduction. French bean is valued for its protein (23%) rich seeds. It also contains K, Ca, Mg, Fe, P, vitamins A, B, and D, starch, and no fat” [2]. In 2016, World production of green beans was 23.6 million tons, led by China with 79% of total production (FAOSTAT, 2017), with Myanmar, India, and Brazil as leading producers. In India, more than 90 per cent of total pulse production 10 states viz., Madhya Pradesh, Maharashtra, Rajasthan, Uttar Pradesh, Karnataka, Andhra Pradesh, Gujarat, Jharkhand, Tamil Nadu, and Telangana.

“Sulphur plays an important role in legume production. Helps to promote root growth and convert nitrogen into protein. It is also an important macronutrient involved in the synthesis of amino acids such as cysteine, cystine, methionine, and vitamins” [3,4]. “Sulphur is an essential element in the production of legumes and is an integral part of proteins, Sulphur lipids, enzymes, etc. The response has been observed in several legumes, including French beans, and application to low - Sulphur soils has been found to increase crop yield and improved crop quality” [5]. Sulphur supports the uptake and utilization of other essential nutrients such as nitrogen, contributing to enhanced growth and increased yield in French beans.

Almost all organisms require iron as a micronutrient. Legumes are susceptible to iron deficiency, just like other crops. Numerous

physiological and biochemical processes, including photosynthesis, respiration, DNA synthesis, and nitrogen fixation, are known to depend on iron. It is required for various biological functions as it serves as a building block for many important enzymes such as cytochromes in the electron transport chain. Iron is involved in chlorophyll synthesis in plants and is essential for maintaining chloroplast structure and function.

## 2. MATERIALS AND METHODS

The experiment is conducted to know the Response of French beans to Sulphur and iron application on growth and yield and was carried out at Crop Research Farm of Sam Higginbottom University, Prayagraj, Uttar Pradesh in 2022. The soil was sandy loam in texture, medium in available nitrogen (238.12 kg/ha), low in Phosphorous (38.3 kg/ha<sup>-1</sup>), and medium in potassium (244.8 kg/ha<sup>-1</sup>). The experiment was laid out in an RBD consisting of ten treatments including Control with 3 replications, viz., (T<sub>1</sub>) Sulphur 15 kg/ha<sup>-1</sup> + Iron 0.25 % at 20 DAS, (T<sub>2</sub>) Sulphur 15 kg/ha<sup>-1</sup> + Iron 0.5 % at 20 and 30 DAS, (T<sub>3</sub>) Sulphur 15 kg/ha<sup>-1</sup> + Iron 0.75 % at 30 and 40 DAS, (T<sub>4</sub>) Sulphur 30 kg/ha<sup>-1</sup> + Iron 0.25 % at 20 DAS, (T<sub>5</sub>) Sulphur 30 kg/ha<sup>-1</sup> + Iron 0.5 % at 20 and 30 DAS, (T<sub>6</sub>) Sulphur 30 kg/ha<sup>-1</sup> + Iron 0.75 % at 30 and 40 DAS, (T<sub>7</sub>) Sulphur 45 kg/ha<sup>-1</sup> + Iron 0.25 % at 20 DAS, (T<sub>8</sub>) Sulphur 45 kg/ha<sup>-1</sup> + Iron 0.5 % at 20 and 30 DAS, (T<sub>9</sub>) Sulphur 45 kg/ha<sup>-1</sup> + Iron 0.75 % at 30 and 40 DAS, (T<sub>10</sub>) Control. The French bean seeds were sown at a spacing of 45 cm x 10 cm with a seed rate of 50 – 75 kg/ha<sup>-1</sup>. According to Ganie et al. [6], as the Sulphur dose was increased, growth like plant height and dry weight and yield-attributing characteristics, such as the number of seeds per pod, have considerably increased. The yield contributing characters such as the number of pods per plant, number of seeds per pod, seed yield, and stover yield were recorded at the time of harvest and averages were calculated and the data were statistically analyzed using the ANOVA technique (Gomez, 1976).

### 3. RESULTS AND DISCUSSION

#### 3.1 Response of Sulphur and Iron Application on Growth Attributes of French Bean

The observation related to growth attributes were presented below (Table 1), significantly, the maximum plant height (46.43 cm) and plant dry weight (27.21 g) were recorded under Sulphur 45 kg/ha<sup>-1</sup> + Iron 0.5 % at 20 and 30 DAS. Sulphur fertilization improves the nutritional environment both in the rhizosphere and plant system. The increased availability of nutrients in root zone coupled with increased metabolic activity may have increased the potassium, Sulphur, and boron absorption, accumulation, and uptake subsequently [7]. However, Fe and S are necessary for the biosynthesis of chlorophyll, cytochrome, and amino acids leading to an increase in plant height and number of pods. This might be due to their role in starch formation and protein synthesis as well as maintenance and synthesis of chlorophyll in plants. The increase in the availability of iron to plants might have stimulated the metabolic and enzymatic activities thereby increasing the growth of crop. Similar findings were also reported by branches [8].

#### 3.2 Response of Sulphur and Iron Application on Yield Attributes of French Bean

The observations on yield attributes were presented below (Table 2). Maximum number of pods/plant (16.67), number of seeds/pods (5.67), seed index (43.65), maximum seed yield (1.88 t/ha<sup>-1</sup>), stover yield (5.39 t/ha<sup>-1</sup>) were recorded significantly higher with Sulphur 45kg/ha<sup>-1</sup> + Iron

0.5 % at 20 and 30 DAS. Sulphur content also increases due to rapid absorption and translocation of Sulphur by plants with adequate Sulphur from the soil [9] leading to improved Sulphur content and uptake by the crop. As the Sulphur dose was increased, other yield-related parameters such as the number of pods per plant, the number of seeds per pod, and the weight of 100 seeds significantly increased.

The higher rate of photosynthesis and sugar formation due to increased chlorophyll synthesis and enzyme activity, results in the translocation of more photosynthates to growing pods, which ultimately leads to higher production of dry matter and more yield and are directly influenced by micronutrients, specifically iron, and zinc. Micronutrients Dongre et al. [10] stated that they catalyze several reactions in plant metabolism. The improvement in yield due to an increase in Sulphur levels might be due to its important role in energy transformation, activation of enzymes, and carbohydrate metabolism [11].

Fe is required for the manufacture of cytochrome and chlorophyll, which results from increases in plant height and branching [12]. This may be a result of its function in the production of protein and starch as well as in the upkeep and synthesis of chlorophyll in plants. Increased iron availability to plants may have sped up their enzymatic and metabolic processes, boosting the crop's growth. Trivedi et al. [8] also reported similar results. This is most likely because; it contributes to the production of proteins, amino acids, and chlorophyll, which in-turn helps plants expand their capacity for photosynthetic activity [13].

**Table 1. Response of sulphur and iron application on growth parameters of French bean**

Treatments	Plant height (cm)	Plant dry weight (g/plant)
	39.20	
Sulphur 15kg/ha + Iron 0.25 % at 20 DAS		23.61
Sulphur 15kg/ha + Iron 0.5 % at 20 DAS and 30 DAS	41.10	26.01
Sulphur 15kg/ha + Iron 0.75 % at 30 DAS and 40 DAS	40.96	23.29
Sulphur 30kg/ha + Iron 0.25 % at 20 DAS	39.21	24.01
Sulphur 30kg/ha + Iron 0.5 % at 20 DAS and 30 DAS	43.88	27.01
Sulphur 30kg/ha + Iron 0.75 % at 30 DAS and 40 DAS	43.90	26.44
Sulphur 45 kg/ha + Iron 0.25 % at 20 DAS	38.73	25.09
Sulphur 45 kg/ha + Iron 0.5 % at 20 DAS and 30 DAS	46.43	27.21
Sulphur 45 kg/ha + Iron 0.75 % at 30 DAS and 40 DAS	44.01	26.52
120 – 60 – 50 Kg NPK/ha (Control)	36.29	22.79
Sem (±)	1.73	1.04
CD (p=0.05)	5.14	3.09

**Table 2. Response of sulphur and iron application on yield parameters of french bean**

<b>Treatments</b>	<b>Pods/plant (No)</b>	<b>Seeds/pod (No)</b>	<b>Seed index (g)</b>	<b>Seed yield (t/ha)</b>	<b>Stover yield (t/ha)</b>
Sulphur 15kg/ha + Iron 0.25 % at 20 DAS	13.00	3.93	38.53	1.52	4.59
Sulphur 15kg/ha + Iron 0.5 % at 20 DAS and 30 DAS	14.00	4.60	40.83	1.65	5.19
Sulphur 15kg/ha + Iron 0.75 % at 30 DAS and 40 DAS	14.00	5.00	36.90	1.43	4.54
Sulphur 30kg/ha + Iron 0.25 % at 20 DAS	13.00	4.33	41.26	1.72	5.10
Sulphur 30kg/ha + Iron 0.5 % at 20 DAS and 30 DAS	16.00	5.33	43.06	1.80	5.36
Sulphur 30kg/ha + Iron 0.75 % at 30 DAS and 40 DAS	15.00	4.87	42.56	1.79	5.31
Sulphur 45 kg/ha + Iron 0.25 % at 20 DAS	14.67	4.13	39.64	1.78	5.14
Sulphur 45 kg/ha + Iron 0.5 % at 20 DAS and 30 DAS	16.67	5.67	43.65	1.88	5.39
Sulphur 45 kg/ha + Iron 0.75 % at 30 DAS and 40 DAS	15.00	5.00	42.81	1.76	5.20
120 – 60 – 50 Kg NPK/ha (Control)	13.00	4.13	35.79	1.02	4.50
Sem ( $\pm$ )	0.72	0.19	1.65	0.02	0.08
CD ( $p=0.05$ )	2.15	0.58	4.90	0.08	0.24

#### 4. CONCLUSION

It is concluded present investigation that basal application of Sulphur 45kg/ha<sup>-1</sup> and foliar spray of iron 0.5 % at 20 and 30 DAS along with RDF was found suitable for obtaining higher yield in French beans.

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#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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