Response of sulfur and iron application on growth and yield of French bean

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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 the *Rabi* season of 2022 on sandy loam soil. The experiment consists of three levels of Sulfur *viz*., 15 kg ha^{-1}, 30 kg/ha, 45 kg/ha 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 of NPK (farmer's practice), which were replicated thrice. The variety Arka Komal of French bean was sown in November 2022. The results of the experiment revealed that the application of 45 kg/ha 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)

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Keywords: French bean, Growth parameters, Iron, Sulphur, Yield attributes.

INTRODUCTION

French bean (*Phaseolus vulgaris* L.) belongs to the family Leguminoceae and occupies a premier place among grain legumes in the World wide including India. 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 of worldwide significance for human consumption because it is a rich source of proteins, vitamins, and minerals. French bean is also one of the most important pulse in the country including North East India (Beauty, 2020). 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 it's protein (23%) rich seeds. It also contains K, Ca, Mg, Fe, P, vitamins A, B, and D, starch, and no

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fat (Usha *et al.*, 2019). In the World, French bean is cultivated mainly in American and European countries such as America, England, Poland, Brazil, Mexico, Myanmar, China, and India. In 2016, World production of green beans was 23.6 million tons, led by China with 79% of total production (FAOSTAT, 2017). World dried bean production in 2016 was 26.8 million tons, with Myanmar, India, and Brazil as leading producers. In India, more than 90 per cent of total pulse production has been the contribution of 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. Sulfur is an essential element in the production of legumes and is an integral part of proteins, sulfur lipids, enzymes, etc. The response has been observed in several legumes, including French beans, and application to low-sulfur soils has been found to increase crop yield and improved crop quality (Kumar *et al.*, 2009). In the past, air-fixed sulfur fertilizer applications were likely to meet industrial needs in developed countries of Western Europe and North America (Feinberg et al, 2021). The population is increasing day by day, making it difficult to meet the food demand. As a result, more cultivars with high yields, short harvest times, responsiveness to fertilizers, etc, and resistance to pest and disease infestations are being introduced for food production. Sulfur supports the uptake and utilization of other essential nutrients such as nitrogen, contributing to enhanced growth and increased yield in French beans.

Iron is an essential micronutrient for almost all organisms. As in other crops, iron deficiency limits the production of legumes. Iron is known to be essential for many physiological and biochemical processes such as photosynthesis, respiration, DNA synthesis, and nitrogen fixation. It is required for various biological functions as it serves

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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. Green beans are an excellent source of protein and fiber. Vitamins A, B complex, minerals iron, magnesium, manganese, potassium. Iron is also essential for various enzymatic processes in plants. Iron has a positive impact on the growth and yield of French beans. The application of iron boosts chlorophyll synthesis, improving the ability of plants to capture sunlight and carry out photosynthesis effectively. This promotes plant growth and increases productivity.

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MATERIAL AND METHODS

The experiment is conducted to know the Response of French beans to Sulfur 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), and medium in potassium (244.8 kg/ha). The experiment was laid out in an RBD consisting of ten treatments including Control with 3 replications, *viz.*, (T_1) Sulphur 15 kg/ha + Iron 0.25 % at 20 DAS, (T2) Sulphur 15 kg/ha + Iron 0.5 % at 20 and 30 DAS, (T3) Sulphur 15 kg/ha + Iron 0.75 % at 30 and 40 DAS, (T4) Sulphur 30 kg/ha + Iron 0.25 % at 20 DAS, (T5) Sulphur 30 kg/ha + Iron 0.5 % at 20 and 30 DAS, (T6) Sulphur 30 kg/ha + Iron 0.75 % at 30 and 40 DAS, (T7) Sulphur 45 kg/ha + Iron 0.25 % at 20 DAS, (T8) Sulphur 45 kg/ha + Iron 0.5 % at 20 and 30 DAS, (T9) Sulphur 45 kg/ha + Iron 0.75 % at 30 and 40 DAS, (T10) 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. According to Ganie *et al.* (2014), as the Sulfur 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

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averages were calculated and the data were statistically analyzed using the ANOVA technique (Gomez, 1976).

RESULTS AND DISCUSSION

Effect 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 45kg/ha + Iron 0.5 % at 20 and 30 DAS. Sulfur 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, Sulfur, and boron absorption, accumulation, and uptake subsequently (Jat and Mehra, 2007). 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 …… 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 (Prasad et al, 1984, Kumar et al, 2021, Jana and Jahangir, 1987, Trivedi et al, 2011).

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Response of Sulfur 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), stover yield (5.39 t/ha) were recorded significantly higher with Sulphur 45kg/ha + Iron 0.5 % at 20 and 30 DAS. Sulfur content also increases due to rapid absorption and translocation of Sulfur by plants with adequate Sulfur from the soil (Shrivastava *et al.,* 2000) leading to improved Sulfur content and uptake by the crop. As the Sulfur 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, which 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.* (2000) also stated that they catalyze several reactions in plant metabolism. The improvement in yield due to an increase in sulfur levels might be due to it's important role in energy transformation, activation of enzymes, and carbohydrate metabolism (Davidian and Kopriva, 2010).

Fe is required for the manufacture of cytochrome and chlorophyll, which results from increases in plant height and branching (Prasad *et al.,* 1984; Jana and Jahangir, 1987). This may be a result of it's 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.* (2011) 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 (Juszczuk and Ostaszewska, 2011).

CONCLUSION

It is concluded present investigation that basal application of Sulphur 45kg/ha 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. Since, the finding based on the research done in one season.

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Table 1: Effect of sulfur and iron on growth parameters of French bean.

Treatments	Plant height (cm)	Plant Dry Weight (g/plant)
Sulfur 15kg/ha + Iron 0.25 % at 20 DAS	39.20	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: Effect of sulphur and iron on yield parameters of French bean.

Treatments	Pods/plant (No)	Seeds/pod (No)	Seed index (g)	Seed yield (t/ha)	Stover yield (t/ha)
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 (±)	0.72	0.19	1.65	0.02	0.08
CD (p=0.05)	2.15	0.58	4.90	0.08	0.24