Influence of Zinc and Boron application on growth and yield of French Bean (*Phaseolus vulgaris* L.)

ABSTRACT

A field experiment was conducted during *Rabi* 2022 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj(U.P). The experiment was laid out in Randomized Block Design with nine treatments each replicated thrice based on one year of experimentation. The application of Zinc 45kg/ha^{-1} + Boron 0.5% @ 15DAS, recorded significantly higher Plant height (44.00 cm), Plant dry weight (29.31 g/plant). Significantly maximum pods/plant (17.40), Seeds/pod (7.00), Seed index (44.04 g), Seed yield (1.37 t/ha), stover yield (3.21 t/ha) were recorded with the treatment of Zinc 45kg/ha^{-1} + Boron 0.5% @ 15DAS.

Keywords: Boron, Economics, French Bean, Growth parameter, Zinc.

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INTRODUCTION

Green beans are young, unripe fruits of various cultivars of the common bean (*Phaseolus vulgaris*), although immature or young pods of the runner bean (*Phaseolus coccineus*), yardlong bean (*sesquipedal's*), and hyacinth bean (*Lablab purpureus*) are used similarly. Green beans are known by many common names, including French beans (French: haricot vert), string beans (although most modern varieties are "stringless"), and snap beans or simply "snaps. **(Singh 2015)** In the Philippines, they are also known as "Baguio beans" or "habichuelas" to distinguish them from yard-long**(Maribehlla 2019).** They are distinguished from the many other varieties of beans in that green beans are harvested and consumed with their enclosing pods before the bean seeds inside have fully matured. An analogous practice is the harvest and consumption of unripened pea pods, as is done with snow peas or sugar snap peas.

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Over 130 varieties (cultivars) of edible pod beans are known, Varieties specialized for use as green beans, selected for the succulence and flavour of their green pods, are the ones usually grown in the home vegetable garden, and many varieties exist. Beans with various pod colours (green, purple, red, or streaked, **Singh BK 2011**) are collectively known as snap beans, while green beans are exclusively green. Shapes range from thin "fillet" types to wide "romano" types and more common types in between. The three most commonly known types of green beans belonging to the species *Phaseolus vulgaris* are string or snap beans, which may be round or have a flat pod; stringless or French beans, which lack a tough, fibrous string running along the length of the pod; and runner beans, which belong to a separate species, Phaseolus coccineus. Green beans may have a purple

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rather than green pod, which changes to green when cooked. Yellow-podded green beans are also known as wax beans. Wax bean cultivars are commonly of the bush or dwarf form.

Zinc is a vital micronutrient required for each living organism and plays several essential roles in life, growth, and development; it shows an essential role in the normal physiological activities of growth and development **(**Stanton *et al.*, 2022**;** Wu *et al.*, 2022**).** Zn is an essential trace metal with structural roles in controlling proteins, as an enzyme cofactor **(**Sobczyk and Gaunt, 2022**)**, and it performs as a cofactor for several enzymes involved in numerous processes such as DNA replication, protein synthesis, and metabolism of lipids. In addition, Zn plays a major role in numerous plant metabolic processes, such as enzyme activity, photosynthesis, chlorophyll synthesis, and other biochemical functions **(**Grüngreiff*et al.*, 2020**).** Zn is the second highly abundant trace element necessary for all living organisms. It occurs as a divalent cation (Zn2+) and is not redox active under physiological conditions, which explains the Zn performance in different physiological roles in a range of biological activities. The high zinc level singly applied, significantly reduced the yield of bean roots. There are several examples demonstrating that applying Zn fertilizers or Zn enriched NPK fertilizers to crops improves not only productivity but also grain Zn concentration of plants. Zinc is involved in auxin formation, activation of dehydrogenase enzymes; stabilization of ribosomal fractions. Currently, Zn deficiency is listed as a major risk factor for human health and death globally. Boron (B) is a micronutrient critical to the growth and health of all crops. It is a component of plant cell walls and reproductive structures. It is a mobile nutrient within the soil, meaning it is prone to movement within the soil.

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MATERIAL AND METHODS

The experiment conducted to know the Influence of Zinc and Boron application on the growth and yield of French Bean (*Phaseolus vulgaris* L.)was carried out at the 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^{-1}), and medium in potassium (244.8 kg/ha^{-1}). The experiment was laid out in an RBD consisting of ten treatments including Control with 3 replications, *viz.*,The treatments which are T_1: Zinc 15kg/ha^{-1} + Boron 0.5% @ 15DAS, T_2: Zinc 15kg/ha^{-1} + Boron 0.6% @ 25DAS, T_3: Zinc 15kg/ha^{-1} + Boron 0.7% @ 55DAS, T_4: Zinc 30kg/ha^{-1} + Boron 0.5% @ 15DAS, T_5: Zinc 30kg/ha^{-1} + Boron 0.6% @ 25DAS, T_6: Zinc 30kg/ha^{-1} + Boron 0.7% @ 55DAS, T_7: Zinc 45kg/ha^{-1} + Boron 0.5% @ 15DAS, T_8: Zinc 45kg/ha^{-1} + Boron 0.6% @ 25DAS,T_9: Zinc 45kg/ha^{-1} + Boron 0.7% @ 55DAS, T_{10}:Control are used. The French bean seeds were sown at a spacing of 35 cm x

10 cm with a seed rate of 50 – 75 kg/ha^{-1},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.

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RESULTS AND DISCUSSION

Influence of zinc and boron on the growth of French bean

Plant height: At 80 DAS, there was a significant difference among the treatments. However, the highest plant height (44.00 cm) was recorded with the application of Zinc 45kg/ha^{-1} + Boron0.5%@15DAS, whereas the minimum plant height (36.90 cm) was recorded with the treatment Control 120:60:50 (N:P:K) kg/ha^{-1} and Zinc 30kg/ha^{-1} + Boron 0.5% @ 15DAS (33.30 cm), Zinc 15kg/ha^{-1} + Boron 0.5% @ 15 DAS (32.97 cm) were statistically at par with T7.This might be due to the quick availability of boron to crop during the entire growing season. Boron plays an important role in tissue differentiation and carbohydrate metabolism. It is also a constituent of cell membrane and essential for cell division, and maintenance of conducting tissue with regulatory effect on other element. Similar results were shown by Alam *et al.* (2014).

Plant dry weight: highest dry weight (29.31 g) was recorded with the application of Zinc 45kg/ha^{-1} + Boron 0.6% @ 15DAS, whereas the minimum plant dry weight (24.65 g) was recorded with the treatment Control 120:60:50 (N:P:K) kg/ha^{-1} and Zinc 30kg/ha^{-1} + Boron 0.5% @ 15DAS (29.05 g) was statistically at par with T7. This might be due to the quick availability of boron to crop during the entire growing season. Boron plays an important role in tissue differentiation and carbohydrate metabolism. It is also a constituent of the cell membrane and essential for cell division, and maintenance of conducting tissue with a regulatory effect on another element (Rahman *et al.*, 2013).

Influence of zinc and boronon yield attributes of French bean

Number of Pods/plants: The perusal of the data of the number of Pods/plants recorded at harvest, is presented in Table 1. The data reveals that there was a significant effect among different treatments on the Number of Pods/plants.

The maximum number of Pods/plant (17.40) was recorded with the treatment of the application of Zinc 45kg/ha^{-1} + Boron 0.5 % @ 15DAS over all the treatments, and the minimum was recorded in Control 120:60:50 (N:P:K) kg/ha^{-1} (10.00). However, the treatments Zinc 30kg/ha^{-1} + Boron 0.5 % @ 15DAS (17.07), and Zinc 15kg/ha^{-1} + Boron 0.5% @15DAS (16.80) which was found to be statistically at par with T7. This might be due to the role of zinc in the production of biomass and that iron is necessary for chlorophyll synthesis and has many essential roles in plant growth and development (Abdollahi *et al.*, 2010).

The number of Seeds/Pod: Significantly Maximum Number of seeds/pods (7.00) was recorded with the treatment of the application of Zinc 45kg/ha^{-1} + Boron 0.5% @ 15DAS over all the treatments, and the minimum was recorded in Control 120:60:50 (N:P:K) kg/ha^{-1} (4.07). However, the treatments Zinc 30kg/ha^{-1} + Boron 0.5% @ 15DAS (6.00), and Zinc 15kg/ha^{-1} + Boron 0.5% @ 15DAS (6.40) which was found to be statistically at par with T7. The improvement might be due to an increase in the germination percentage of seed inside the pod and may be due to boron making stigma receptive and sticky and making pollen grain fertile and enhancing the pollination. Thus, increased fruit setting reduces the sterility of the flowers and the number of grains per pod increases. Similar results were reported by Zaman et al. (1996).

Seed index (g): Highest seed index (44.04 g) was recorded with the treatment of the application of Zinc 45kg/ha^{-1} + Boron 0.5% @ 15DAS over all the treatments and the minimum was recorded in Control 120:60:50 (N:P:K) kg/ha^{-1} (33.90 g). However, the treatments Zinc 30kg/ha^{-1} + Boron 0.5% @ 15DAS (43.85 g), Zinc 15kg/ha + Boron 0.5% @ 15DAS (42.56 g) which was found to be statistically at par with T7. This improvement in the 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 the grain. Similar results were reported by Padbhushan and Kumar (2014).

Seed yield (t/ha): Significantly Maximum seed yield (1.37 t/ha) was recorded with the treatment of the application of Zinc 45kg/ha + Boron0.5%@15DAS over all the treatments, and the minimum was recorded in Control 120:60:50 (N:P:K) kg/ha (1.22 t/ha). However, the treatments Zinc 30kg/ha + Boron0.5%@15DAS (1.34 t/ha), Zinc 15kg/ha + Boron0.5%@15DAS (1.33 t/ha) which was found to be statistically at par with T7. Improvement in yield might be due to B application which is attributed to the 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. Similar results were reported by Kaiser *et al*. (2010).

Stover yield (t/ha): Significantly Maximum stover yield (3.21 t/ha) was recorded with the treatment of the application of Zinc 45kg/ha^{-1} + Boron0.5%@15DAS over all the treatments, and the minimum was recorded in Control 120:60:50 (N:P:K) kg/ha^{-1} (2.95 t/ha). However, the treatments Zinc 30kg/ha^{-1} + Boron0.5%@15DAS (3.20 t/ha^{-1}), Zinc 15kg/ha^{-1} + Boron0.5%@15DAS (3.19 t/ha^{-1}) which was found to be statistically at par with T7.

CONCLUSION

It is concluded that the application of Zinc 45kg/ha^{-1} + Boron 0.5% at 15DAS recorded higher seed yieldas compared to other treatmentsand was found suitable for obtaining higher yield in French beans.

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Table 1: influence of Zinc and Boron on growth parameters of French bean.

Treatments	Plant height (cm)	Plant Dry Weight (g/plant)
Zinc 15kg/ha + Boron0.5%at15DAS	42.37	27.89
Zinc 15kg/ha + Boron0.6%at25DAS	38.40	27.19
Zinc 15kg/ha + Boron0.7%at55DAS	37.40	26.89
Zinc 30kg/ha + Boron0.5%at15DAS	43.40	29.05
Zinc 30kg/ha + Boron0.6%at25DAS	38.40	27.52
Zinc 30kg/ha + Boron0.7%at55DAS	37.45	27.01
Zinc 45kg/ha + Boron0.5%at15DAS	44.00	29.31
Zinc 45kg/ha + Boron0.6%at25DAS	40.80	27.80
Zinc 45kg/ha + Boron0.7%at55DAS	38.03	27.10
Control (RDF) 120:60:50 Kg NPK/ha	36.90	24.65
Sem (±)	0.41	0.23
CD(p=0.05)	1.24	0.69

Table 2:influence of Zinc and Boron onyield parameters of French bean.

Treatments	Pods/plant (No)	Seeds/pod (No)	Seed index (g)	Seed yield (t/ha)	Stover yield (t/ha)
Zinc 15kg/ha + Boron0.5%at15DAS	16.80	6.40	42.56	1.32	3.19
Zinc 15kg/ha + Boron0.6%at25DAS	12.00	5.07	38.97	1.29	3.16
Zinc 15kg/ha + Boron0.7%at55DAS	11.00	3.93	35.78	1.26	3.05
Zinc 30kg/ha + Boron0.5%at15DAS	17.07	6.60	43.85	1.33	3.20
Zinc 30kg/ha + Boron0.6%at25DAS	14.00	4.93	40.78	1.31	3.17
Zinc 30kg/ha + Boron0.7%at55DAS	10.00	3.93	36.99	1.27	3.08
Zinc 45kg/ha + Boron0.5%at15DAS	17.40	7.00	44.04	1.37	3.21
Zinc 45kg/ha + Boron0.6%at25DAS	16.00	6.00	41.18	1.31	3.18
Zinc 45kg/ha + Boron0.7%at55DAS	11.00	3.93	38.25	1.28	3.09
Control (RDF) 120:60:50 Kg NPK/ha	10.00	4.07	33.90	1.22	2.95
Sem (±)	0.50	0.13	0.68	0.01	0.03
CD(p=0.05)	1.49	0.39	2.03	0.03	0.02