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Effect of Nano Zinc and Foliar Application of Boron on Growth and Yield of Finger Millet

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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 during Kharif 2022 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P) to determine the "Effect of nano zinc and foliar application of boron on growth and yield of finger millet (*Eleusine coracana* L.)". The experiment was laid out in Randomized Block Design comprising of 10 treatments which include of three levels of [Nano zinc 300 ppm, 600 ppm, 900 ppm] and three levels of foliar application of Boron at [0.1%, 0.3% and 0.5%], whose effect is observed in finger millet. The results revealed that the treatment with application of Nano zinc 900 ppm + Boron at 0.5% recorded higher plant height, number of tillers/plant, plant dry weight, CGR,RGR and yield parameter test weight, seed yield, stover yield and harvest index.

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1. INTRODUCTION

Finger millet (*Eleusine coacana* L. Garten) is known as African millet and Ragi in India. Finger millet belonging to the family Poaceae. The third most important millet crop in India. India's thirdlargest millet crop. One of the main food staples in some regions of eastern and central Africa and India is finger millet. In Karnataka, Tamil Nadu, Andhra Pradesh, Orissa, Bihar, and Maharashtra there has been tremendous development. Even in the mountains of Himachal Pradesh and Uttar Pradesh, it develops. It generated yearly in 1.29 million tonnes on 2.5 million hectares (M/ha) of land**.** An important grain crop, ragi is a C_4 plant with such a high production potential which, under perfect situations, could reach up to 40 to 50 quintals per hectare.

Millets have a higher nutrient value than other grains like rice and wheat. It performs well as a substitute for rice and wheat. Proteins (5-8%), carbs (65-75%), dietary fibre (15-20%), minerals (2.5-3.5%), and other extractives (1-2%) are all present in finger millet. Among the cereals, it has the greatest calcium content (344 mg/100 g).

Most developing nations have long relied heavily on agriculture as their economic engine. It not only fills people's stomachs but also stimulates the economy. India has a population of 1.27 billion as of the 2014–2015 censuses. There must be a new technology that provides more yield in a short amount of time due to the issue of feeding such a large population. Inorganic fertilisers are delivered in order to offer three primary components, nitrogen, phosphorous, and potassium in similar ratios, and are sprayed in numerous methods, including on soil, through leaves, and even in aquatic environments [1]. Nano fertilisers have a three-fold improvement in nutrient utilisation efficiency (NUE) and stress tolerance.Regardless of the type of crop, nanotechnology can be utilised to maximise bio source usage, make agriculture more environmentally friendly, increase carbon uptake, and enhance soil aggregation.These nano fertilisers will also have a show and targeted efficient release technology because they contain nutrients and growth boosters enclosed in nano scale polymers.

"Zinc deficiency is now recognized as one of the most widespread mineral deficiencies in global human nutrition. Zinc is required for the structural and functional integrity of about 2800 proteins, contributes to protein biosynthesis and is a key defence factor in the detoxification of highly toxic oxygen-free radicals" [2].

"Concluded that foliar or combined soil and foliar application of zinc fertilizer under field conditions a highly effective and very practical way to maximize the uptake and accumulation of zinc in whole wheat grain. Finger millet flour fortified with zinc-oxide was specifically examined for the bio accessibility of the fortified mineral, as measured by in- vitro, stimulated gastrointestinal digestion procedure and storage stability" [3].

Nutrients including zinc and boron are recommended. Zinc, among the essential microelements for both plants and animals, is essential to a plant's metabolic process since it promotes the manufacturing of proteins, lipids, carbohydrates, DNA, and enzymes. Zinc is also another important mineral. Serves an essential function in reducing the production and cytotoxicity of free radicals that can damage membrane lipids a lack of zinc affects both vegetative and productive growth, according to research Since the establishment of essentiality of boron for the growth and development of higher plants our knowledge about Its importance in agriculture has grown rapidly.

"In addition to helping with cell division, cell elongation, cell membrane strength, flowering, pollination, seed set, and sugar translocation, boron is essential for the growth and nutrition of crop plants. Although calcium and boron are necessary to improve grain yields, their mixed application can have an effect on the accessibility and use of boron by plants" [4].

"The biological responses of plants, such as cell elongation, cell maturation, meristematic tissue development, and protein synthesis, all benefit from the presence of the element borax" [5]. The use of boron to finger millet is essential for improving the crop's growth, development, and yield. The application of boron also promotes the soil's uptake of nitrogen, which improves plant height and dry weight**.** The information on finger millet's boron content in Karnataka is important. Thereby, the aim of this research was to Research the effects of graduated boron doses on the growth and yield of finger millet, an important staple food crop in Karnataka's

Eastern Dry Zone. Although much research has been performed simultaneously, a thoroughly repeated experiment in various Karnataka regions is needed to determine the considered valid.

2. MATERIALS AND METHODS

The experiment was conducted during the kharif season of 2022 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P). The soil of the field constituting a part of central gangetic alluvium is neutral and deep. The soil of the experimental field was sandy loam in texture, nearly neutral in soil reaction (pH 7.4),low level of organic carbon (0.51%), available N (108.69 Kg/ha), P (80.5 kg/ha), K (83.3 kg/ha) The treatment consists of Nano zinc @ 300ppm + Boron@ 0.1%, Nano zinc @ 300ppm + Boron@ 0.3%, Nano zinc @ 300ppm + Boron@ 0.5%, Nano zinc @ 600ppm + Boron@ 0.1%, Nano zinc @ 600ppm + Boron@ 0.3%, Nano zinc @ 600ppm + Boron@ 0.5%, Nano zinc @ 900ppm + Boron@ 0.1%, Nano zinc @ 900ppm + Boron@ 0.3%, Nano zinc @ 900ppm + Boron@ 0.5% and control.

The experiment was laid out in Randomized Block Design, with 10 treatments replicated thrice. The observations were recorded for plant height, plant dry weight, Crop growth rate (g/m^2/day), Relative growth rate (g/g/day), test weight (g), seed yield (t/ha), strover yield (t/ha) and harvest index (%). The collected data were subjected to statistical analysis by analysis of variance method.

3. RESULTS AND DISCUSSION

3.1 Growth Parameters Plant Height

The data revealed that a significant and higher plant height (36.3 cm) was observed in treatment T_9 [ZnO (900 ppm) + Boron (0.5%)] However, treatment T_8[ZnO (900 ppm) + Boron (0.3%)] where statistically at par with the treatment T_9 [ZnO (900 ppm) + Boron (0.5%)].

This can occur as a result of the largest plant density, which can push plants higher to access sunlight, as well as legumes' role in nitrogen fixation, which supports vegetative development. The current outcome was consistent with Dawit and Nebi's discovery. The findings of Islam et al. [6] however, which noted that the plant height of solitary pearl millet is higher than that of their respective intercrops with cowpea, have been refuted by this outcome. Agroecology, rainfall, soil type, growing temperature, the variety utilised, and other climatic conditions may all contribute to the variation.

3.2 The Number of Tillers/Plant

The data revealed that treatment T_9 [ZnO (900 ppm) + boron (0.5%)] recorded significant and maximum number of tillers/plant (6.4) which was superior to all the treatment and the treatments T_8 [ZnO (900 ppm) + Boron (0.3%)] and T_7 [ZnO (600 ppm) + Boron (0.5%)] were statistically at par with the treatment T_9 [ZnO(900 ppm)+ Boron (0.5%)].

The increased number of tillers due to the application of these micronutrients might be related to their physiological role in plants. The stimulatory effect of Zn on enzymes and on the increased availability of major nutrients might have caused an increased number of tillers in

the present study. These results corroborate the findings of Dadhich and Gupta [7] and Mubshar et al. [8]. The results very clearly indicated that, application of both nutrients increased the number of tillers per hill and also the need for the application of boron at an early stage of the crop to increase tiller numbers. These results are in accordance with the findings of Muhammad et al. [9].

3.3 Plant Dry Weight (g)

Results revealed that treatment T_9 [ZnO (900 ppm) + Boron (0.5%)] recorded siginificantly higher plant dry weight (8.24). which was superior to all the treatment and treatment T_6 [ZnO (600 ppm)+ Boron (0.5%)], were statistically at par with treatment T_9 [ZnO (900 ppm)+ Boron (0.5%)].

Kobraee et al. [10] claimed that “zinc, iron and boron application at the same time could lead to higher dry matter and seed yield as compared to using them separately. Foliar application with micronutrients (Fe, B and Zn) might be due to their critical role in crop growth, involving photosynthesis processes, respiration and other biochemical and physiological activities and thus their importance in achieving higher yields”.

3.4 Crop Growth Rate (g/m^2/day)

The data recorded that during 60-80DAS that treatment T_9 [ZnO (900 ppm) + Boron (0.5%)]

Table 1. Effect of Nano zinc and foliar application of boron on growth of Finger millet crop

Sl. No.	Treatment	60 DAS			60-80DAS	
		Plant height (cm)	Number of tillers/plant	Dry weight (g/plant)	Crop growth rate (g/m^2/day)	Relative growth rate (g/g/day)
1	ZnO (300 ppm) + Boron at (0.1%)	34.0	5.0	7.48	26.37	0.044
2	ZnO (300 ppm) + Boron at (0.3%)	34.3	5.1	7.61	26.84	0.044
3	ZnO (300 ppm) + Boron at (0.5%)	35.1	5.7	8.00	27.68	0.043
4	ZnO (600 ppm) + Boron at (0.1%)	34.8	5.5	7.84	27.04	0.043
5	ZnO (600 ppm) + Boron at (0.3%)	35.5	5.9	8.06	27.55	0.043
6	ZnO (600 ppm) + Boron at (0.5%)	36.2	6.1	8.17	27.77	0.043
7	ZnO (900 ppm) + Boron at (0.1%)	35.0	5.6	7.91	27.33	0.043
8	ZnO (900 ppm) + Boron at (0.3%)	35.9	6.0	8.09	27.87	0.043
9	ZnO (900 ppm) + Boron at (0.5%)	36.3	6.4	8.24	28.50	0.043
10	Control (100:50:50 NPK kg/ha)	32.8	4.9	7.08	26.90	0.046
	F test	S	S	S	S	S
	SEm(±)	0.10	0.16	0.04	0.21	0.0003
	CD (P=0.05)	0.29	0.49	0.11	0.63	0.0001

Table 2. Effect of nano zinc and boron on yield attributes on finger millet

Sl. No.	Treatment	Test weight (g)	Seed yield (t/ha)	Stover yield (t/ha)	Harvest index (%)
1	ZnO (300 ppm) + Boron at (0.1%)	3.50	1.83	3.39	35.09
2	ZnO (300 ppm) + Boron at (0.3%)	3.57	1.91	3.56	34.96
3	ZnO (300 ppm) + Boron at (0.5%)	3.74	2.08	3.98	34.35
4	ZnO (600 ppm) + Boron at (0.1%)	3.61	1.98	3.71	34.80
5	ZnO (600 ppm) + Boron at (0.3%)	3.75	2.14	4.05	34.58
6	ZnO (600 ppm) + Boron at (0.5%)	3.78	2.34	4.14	36.15
7	ZnO (900 ppm) + Boron at (0.1%)	3.63	2.02	3.86	34.37
8	ZnO (900 ppm) + Boron at (0.3%)	3.77	2.20	4.09	34.92
9	ZnO (900 ppm) + Boron at (0.5%)	3.82	2.69	4.29	38.59
10	Control (100:50:50 NPK kg/ha)	3.45	1.78	3.22	35.62
	F test	S	S	S	S
	SEm(±)	0.05	0.05	0.05	0.56
	CD (P=0.05)	0.16	0.14	0.11	1.30

was the highest crop growth rate (28.50 $g/m^2/day$).

3.5 Releative Growth Rate (g/g/day)

The data revealed that during 60-80 DAS, treatment T_{10} control:100:50:50 (NPK kg/ha)recorded a siginificantly higher relative growth rate (0.046 g/g/day).

3.6 Yield Parameter

3.6.1 Test weight

A Significant and maximum test weight (3.82) was recorded in treatment T_9 [ZnO (900) + boron (0.5%)]. However, treatment T_8 [ZnO (900ppm) + boron (0.3%)] was stastically at par with treatment T_9 [ZnO (900) + boron (0.5%)].

3.6.2 Seed yield (t/ha)

Significant and higher seed yield (2.69 t/ha) was obtained in treatment T_9 [ZnO (900) + boron (0.5%)], and there were no statistically at par values.

Consequently, providing zinc and boron to a soil low in those elements improved plant development and growth in general, which in turn will increase crop yields of grain and straw. Again several research in various crops, such as those by Shrivastava et al. [11], Sammauria [12], Singh et al. [13], Tripathi et al. [14], and Jat et al. [15], also support these conclusions. The combined use of Zn and B in this experiment improved crop yield much more than both element's application alone. These results are similar to Muhammad et al. [9].

3.6.3 Stover yield (t/ha)

Significant and higher seed yield (4.29 t/ha) was obtained in treatment T_9 [ZnO (900) + boron (0.5%)], and there were no statistically at par values.

Sandhya Rani et al. [16] reported higher grain and stover yield (78.1q $ha^{-1}$and 33.7q ha^{-1} respectively) of finger millet with the application of 150% RDF+$ZnSO_4$@0.5% Foliar spray+$FeSO_4$ @ 0.2%. Thus,the application of zinc and boron in a soil deficient in zinc and boron improved the overall growth and development of plants and ultimately the grain and straw yields. These findings are also supported by Shrivastava et al. [11] Sammauria, Singh et al. [12].

3.6.4 Harvest index (%)

A significant and higher harvest index (38.59 %) was obtained in treatment T_9 [ZnO (900) + boron (0.5%)], and there were no statistically at par value.

Baktear Hossain et al. (2001) also reported a similar improvement in the growth and yield of finger millet crops with the application of NPK and Zn. The greater growth, higher photosynthetic activity, and movement of photosynthates from source to harvest are the results of which the yield qualities have improved. The increased supply of nutrients provided by the application of FYM to get fertilizers there with chemical fertilisers may be the cause of the improvement in growth as a result of better physiological processes in plants. Moreover, the application of FYM might have enhanced the physical, chemical, and biological characteristics of the soil, which collectively might have favoured the processes in the soil that change nutrients, leading to an increase in the availability of nutrients. Nutrient uptake by the crop has improved the rise in nutrient availability, the increase in nutrient availability. improved the crop's nutrient uptake, which ultimately led to an improvement in growth and production parameters. According to Mohamed et al. (2010), the application of zinc and boron may have enhanced the transfer of photosynthates from source to sink, which may account for the higher values of yield attributes (2015). Increased plant vigour, improved photosynthesis, and better transfer of photosynthates from source to sink may all contribute to the better yield parameters brought on by the combined application of N, P, K, Zn, and B. [17-25].

4. CONCLUSION

It can be concluded that the application of nano zinc(900ppm) and Boron (0.5%) foliar spray performed better in growth parameters and yield attributes of finger millet (GPU-67). Since the findings are based on one season, further trials are needed to confirm the results.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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