# Effect of Zinc Fortification on Growth and Yield of Finger millet (*Eleusinecoracana* L.)

**Article type :** original Research Article

**ABSTRACT**

A field experiment was conducted during *kharif*2021 at CRF (Crop Research Farm), Department of Agronomy, SHUATS, Prayagraj, (U.P). The soil of the experimental field is sandy loam in texture with a neutral soil pH. The experiment was laid out in a Randomized Block Design with nine treatments and three replications. The treatments consisted of three levels of Zinc *viz.*, 10 kg/ha, 15 kg/ha, 25 kg/ha and three levels of Zinc sulphate at 0.1%, 0.3% and 0.5%,whose effect was observed in finger millet. The results revealed that the treatment with application of 15 kg/ha zinc + 0.5% $Znso_4$ recorded higher plant height (81.22 cm), number of tillers/plant (7.85/plant), plant dry weight (26.32g/plant), and the yield attributes viz.,seed yield (2.79 t/ha),straw yield (4.72 t/ha) and harvest index (37.19%) werealso recorded highest in the treatment with application of 15 kg/ha zinc and 0.5% $Znso_4$.

***Keywords*****:** *Zinc, Zinc sulphate, Growth parameters, Yield attributes, andFinger millet.*

## INTRODUCTION

Finger millet (*Eleusinecoracana* L.) is an important small millet crop grown in India, andit

is distinguished by having the highest productivity among millets. In India finger millet is cultivated over an area of 1.19 million hectares with a production of 1.98 million tones giving an average productivity of 1661 kg per hectare (http://www.indiastst.com). Small-seeded grains belonging to different variety of annual grasses that are cultivated primarily as grain crops on marginal lands in dry areas in temperate, subtropical and tropical regions are collectively referred as millets. They are the most important cereals of semi-arid zones of the world and are staple food for millions of people in Africa and Asia (**Thippeswamy*et al.*, 2016**). It is called finger millet, because the inflorescence resembles the fingers of a human hand.It is an important crop in drought-prone regions because of its outstanding ability to withstand adverse weather conditions and grow in marginal and poor soils.

Finger millet is locally known as ragi and mandua (India). Ragi is commonly known as "Nutritious millet" as the grain is nutritionally superior to many cereals (rice, corn and sorghum) providing proteins, minerals, iron, calcium and vitamins in abundance.When consumed as food, it provides a sustaining diet, especially for people doing hard work. Straw makes valuable fodder for both draught and milch animals. Finger millet is considered as a wholesome food for diabetic patients. Grain may also be malted and flour of the malted grain is used as cakes or porridge and a nourishing food for infants and invalids. **(Chaturvedi and Srivastava 2008).**

Zinc **-** Micronutrients are essential for plant growth and play an important role in balanced crop nutrition. Micronutrients are as important to plant nutrition as primary and secondary nutrients, though plants do not require as much of them. They play a major role in plant growth like protein synthesis, improving seed quality, cell division and pollen tube growth. Deficiency of micronutrients during the last three decades as grown in both magnitude and extent because of increased use of high analysis fertilizers, use of high yielding crop varieties and increasing in cropping intensity. The deficiency of Zn, B and Fe are 49%, 33% and 12% respectively in Indian soils. Among the seven micronutrient elements (Fe, Mn, Cu, Zn, B, Mo, Ca) essential for plant growth, Zn has assumed extensively important place in Indian agriculture **(Singh 2008).**

Zinc plays a key role in plants with enzymes and proteins involved in carbohydrate metabolism, protein synthesis, gene expression, auxin metabolism, pollen formation, maintenance of biological membranes, protection against photo-oxidative damage and heat stress, and resistance to infection by pathogens **(Alloway, 2008).**

Zinc deficiency in plants retards photosynthesis andnitrogen metabolism and reduces flowering. This results in delayed maturity, a decreased yield, and poorquality of finger millet.

Zinc hampers the productivity of cereals, millets and oil seed crops. In addition to the nutritional value of zinc, it is a component of various enzyme systems. It also plays a vital role in biosynthesis of Indole Acetic Acid. It helps in formation of nucleic acids and the synthesis of proteins. **(Dholariya*et al.* 2020).**

Finger millet requires considerable amount of zinc as well as calcium for its growth and development. Deficiency of secondary and micronutrients leads to reduction in the number of effective tillers and improper grain filling (Shetty *et al*. 1993). Finger millet is being increasingly incorporated in breakfast cereals, beverages and infant foods, which makes it an important crop that deserves attention for fortification of its grains with zinc. Therefore,the present study was undertaken to study the effect of zinc fortification on growth and yield of fingermillet.

## MATERIALS AND METHOD

The experiment was conducted during Kharif season 2021. The experiment was laid out in Randomized Block Design consisting of nine treatments each replicated thrice. The treatment combinations are T1: Zinc 10kg/ha+$ZnSo_4$ 0.1% at 30DAS, T2: Zinc 10kg/ha+ Znso4 0.3% at 30DAS, T3: Zinc 10kg/ha+ Znso4 0.5% at 30DAS, T4: Zinc 15kg/ha + Znso4 0.1% at 30DAS, T5: Zinc 15kg/ha+ Znso4 0.3% at 30DAS, T6: Zinc 15kg/ha+ Znso4 0.5% at 30DAS, T7: Zinc 25kg/ha+ Znso4 0.1% at 30DAS, T8: Zinc 25kg/ha+ Znso4 0.3% at 30DAS, T9: Zinc 25kg/ha+ Znso4 0.5% at 30DAS. In each plot five plants were chosen and tagged randomly for recording observations at 20, 40, 60, 80, 100 days after sowing of the crop. Later on statistical analysis was performed using the method of analysis of variance with 5% level of significance for the F-Test.

## RESULTS AND DISCUSSION

**Growth attributes:** The data pertaining to growth attributes given in the table 1.

**Plant Height:**

At harvest, the highest plant height (81.22 cm) was recorded with application of zinc 15 kg/ha + zinc sulphate 0.5% which was significantly superior over rest of the treatments except the treatment with application zinc 10 kg/ha + zinc sulphate 0.5%. The increased plant height might be due to profound influence of Zinc fertilizers on height of plant as increased metabolic process in plant which has prompted meristematic activities causing higher apical growth and photosynthetic area.

**Number of tillers:**

Maximum number of tillers (7.85/plant) was recorded at harvest with application of zinc 15 kg/ha + zinc sulphate 0.5% which was superior over the other treatments and the treatment with zinc 10 kg/ha + zinc sulphate 0.3%, zinc 15 kg/ha + zinc sulphate at 0.3% was statistically at par with treatment 6.

**Dry weight (g/plant):**

At harvest, highest plant dry weight (26.32 g/plant) was recorded with application of zinc 15 kg/ha + zinc sulphate 0.5%which was significantly superior over rest of all the treatments except with application of zinc 15 kg/ha + zinc sulphate 0.3% and zinc 10 kg/ha + zincsulphate0.5%. It might be due to the increase in plant dry weight might be attributed to the optimum and uniform availability of micronutrients in the entire growth period by means of application of nutrients through the soil. There was increased dry weight at successive stages of growth, with the Zinc and iron application **Pradhan*et al*. (2016).** The improved dry matter production and nutrient uptake in finger millet with foliar application of Zinc sulphate at 0.5% was reported by **Ajay Kumar *et al.* (2020).**

**Crop growth rate and relative growth rate:**

Maximum crop growth rate (18.36 g/m2/day) wasrecorded at 80 DAS to harvest with the application of zinc at 10 kg/ha + zinc sulphate 0.5%. wassuperior over the rest of the treatments and statistically on par with the zinc 15 kg/ha + zincsulphate 0.1%, zinc 15 kg/ha + zinc sulphate 0.3% and zinc 15 kg/ha + zinc sulphate 0.5%.

At80 DAS to harvest, maximum relative growth rate (0.0195 g/m 2 /day) was recorded with the application of zinc at 15kg/ha + zinc sulphate at 0.3%, which was superior over the rest of the treatments and there is no statistically significantdifference between them.

**Yield Attributes:**The data pertaining to yield attributes given in the table 2.

At harvest the Superior test weight was recorded with application of Zinc 15 kg/ha + Zinc sulphate 0.5% (3.79 g) and there was no significant difference between the treatment combinations.

**Seed Yield:**

Maximum seed yield was obtained with application of zinc 15 kg/ha + zinc sulphate 0.5% (2.79 t/ha), which was significantly superior over rest of all the treatments except with application of zinc 10 kg/ha + zinc sulphate 0.5% and the treatment with zinc 15 kg/ha + zinc sulphate 0.3%.

The increase in seed yield and straw yield when zinc were sprayed on foliage at tillering stage in finger millet. Foliar application of zinc plays a critical role in crop growth, involving in photosynthesis processes, respiration and other biochemical and physiological activities and thus their importance in achieving higher yields reported by **Zeidan*et al.* (2010)**

**Straw Yield :**

At harvest significantly higher straw yield was obtained with application of zinc 15 kg/ha + zinc sulphate 0.5% (4.72 t/ha), However the treatments with zinc 10 kg/ha + zinc sulphate 0.5%, zinc 10 kg/ha + zinc sulphate 0.3% and zinc 15 kg/ha + zinc sulphate 0.3% are statistically at par with treatment 6. This might be due to profound influence of zinc fertilizers on growth attributes as increased metabolic process in plants which has promoted meristematic activities and photosynthetic process, ultimately better growth resulted in higher yield and yield attributes **(Saraswathi *et al*. 2019).**

**Harvest Index (%):**

Maximum harvest index was obtained with application of zinc 15 kg/ha + zinc sulphate 0.5% (37.19 %),which was significantly superior over rest of all the treatments except with application of zinc 15 kg/ha + zinc sulphate 0.3%, zinc 10 kg/ha + zinc sulphate 0.5% and zinc 10 kg/ha + zinc sulphate 0.3%.

The increase in yield and yield attributes might be due to foliar application of zinc sulphate might be due to increase seed weight. **Sai Divya*et al.* (2021).**

The application of zinc in a soil deficient in zinc improved the overall growth and development of plants and ultimately the grain and straw yields was increased. These findings are also supported by **Shrivatsava*et al.* and *Sammauria*2007.**The improvement in yield attributes is the manifestation of better growth, higher photosynthetic activity and transport of photosynthates from source to sink. The higher values of yield parameters might be due to increased availability of Zinc application.

**Conclusion:**

On the basis of the present experiment on finger millet crop in kharif season, it is concluded that the treatment T6 with application of zinc at 15 kg/ha and 0.5% zinc sulphate recorded higher plant height, dry weight, number of tillers, seed yield and straw yield respectively. Therefore, it is recommended to the farmers to receive higher yield of finger millet.

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**Table 1. Effect of Zinc fortification on growth attributes of finger millet at harvest.**

| Treatments Combinations | Plant height | No. of Tillers/plant | Dry Weight | CGR | RGR |
|---|---|---|---|---|---|
| 1. Zinc 10 kg/ha + Zinc sulphate 0.1% | 77.34 | 6.37 | 24.48 | 16.34 | 0.0178 |
| 2: Zinc 10 kg/ha + Zinc sulphate 0.3% | 78.52 | 6.92 | 23.59 | 15.12 | 0.0170 |
| 3: Zinc 10 kg/ha + Zinc sulphate 0.5% | 80.34 | 7.64 | 25.86 | 18.36 | 0.0191 |
| 4: Zinc 15 kg/ha + Zinc sulphate 0.1% | 78.51 | 6.47 | 24.78 | 17.68 | 0.0193 |
| 5:Zinc 15 kg/ha + Zinc sulphate 0.3% | 79.20 | 7.44 | 25.43 | 18.24 | 0.0195 |
| 6: Zinc 15 kg/ha + Zinc sulphate 0.5% | 81.22 | 7.85 | 26.32 | 18.25 | 0.0186 |
| 7: Zinc 25 kg/ha + Zinc sulphate 0.1% | 78.70 | 6.45 | 24.93 | 17.30 | 0.0187 |
| 8: Zinc 25 kg/ha + Zinc sulphate 0.3% | 78.38 | 6.53 | 23.61 | 15.04 | 0.0168 |
| 9: Zinc 25 kg/ha + Zinc sulphate 0.5% | 76.92 | 6.06 | 22.93 | 13.70 | 0.0156 |
| **SEm(±)** | 0.62 | 0.18 | 0.43 | 0.91 | 0.00 |
| **CD (P=0.05)** | 1.87 | 0.53 | 1.30 | 2.72 | - |

**Table 2. Effect of zinc fortification on yield and yield attributes of finger millet.**

| Treatments | Test weight (gm) | Seed yield (t/ha) | Straw yield (t/ha) | Harvest Index (%) |
|---|---|---|---|---|
| 1. Zinc 10 kg/ha + Zinc sulphate 0.1% | 3.51 | 2.48 | 4.48 | 35.64 |
| 2: Zinc 10 kg/ha + Zinc sulphate 0.3% | 3.57 | 2.59 | 4.58 | 36.09 |
| 3: Zinc 10 kg/ha + Zinc sulphate 0.5% | 3.67 | 2.67 | 4.67 | 36.37 |
| 4: Zinc 15 kg/ha + Zinc sulphate 0.1% | 3.41 | 2.51 | 4.52 | 35.67 |
| 5:Zinc 15 kg/ha + Zinc sulphate 0.3% | 3.57 | 2.63 | 4.57 | 36.57 |
| 6: Zinc 15 kg/ha + Zinc sulphate 0.5% | 3.79 | 2.79 | 4.72 | 37.19 |
| 7: Zinc 25 kg/ha + Zinc sulphate 0.1% | 3.48 | 2.43 | 4.41 | 35.56 |
| 8: Zinc 25 kg/ha + Zinc sulphate 0.3% | 3.53 | 2.36 | 4.39 | 34.99 |
| 9: Zinc 25 kg/ha + Zinc sulphate 0.5% | 3.42 | 2.29 | 4.31 | 34.65 |
| **SEm (±)** | 0.08 | 0.04 | 0.06 | 0.47 |
| **CD (P=0.05)** | - | 0.13 | 0.19 | 1.42 |