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Effect of foliar application of iron and zinc on yield and economics of finger millet (*Eleusine coracana*. L)

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Abstract
A Field experiment was conducted during *kharif* season 2020 at crop research farm (CRF), Department of agronomy SHUATS Prayagraj The experiment was laid out in Randomized Block Design with three replications to investigate the effect of foliar application of Iron and Zinc on yield and economics of Finger millet. The treatments consisted of $ZnS0_4$0.2%, 0.4%, and 0.6%and $FeS0_4$ 0.2% and 0.5% through foliar application whose effect is observed in Finger millet (var MR-1). Study revealed that the application of 0.6% $ZnSO_4$+0.5% $FeSO_4$ through foliar application was recorded highest grain yield (3.93t/ha) Stover yield (6.03) as compared to all treatments. The economic analysis clearly indicate that Maximum Gross returns (INR87573.33), Net returns (INR56639.08) and B:C ratio (1.83) was recorded with the treatment 0.6%$ZnSO_4$ + 0.5%$FeSO_4$ respectively.

Keywords: finger millet, iron, zinc, yield, economics

Introduction
Ragi is the third most important millet crop of India, next to sorghum (*Sorghun bicolor* L.) and pearl millet (*Pennisetum glaucum* L.). The total area under ragi in India is 11.38 ha with production of 18.22 tonnes and productivity of 16.01 kg ha (India stat. 2016). Among different states of India, Karnataka ranked first both in area and production, while Tamilnadu recorded the very best productivity followed by Karnataka during 2016-17. In Uttar Pradesh, the total area under ragi is 1000 ha with production of 1000 tonnes and productivity of 1000 kg ha (India stat, 2016). It is a native African crop which is extremely important in south Asia (India and Nepal). There is a growing realization that millets including ragi would produce more dependable harvest compared to other crops especially under marginal and sub marginal conditions of soil fertility and limited moisture (Seetharam, 1986) [10] The crop is considered as low status food or food of marginalized communities. Intensification of production and increasing yield on limited arable land are important in securing an adequate food supply apart from extending the area under rainfed situation with suitable package of practices (Divyashree.*et al* 2018) [3] it is an important food grain crop of semi aid tropics, particularly of India and East Africa. Finger millet is not only a major food grain crop but also an excellent fodder for cattle The grain of Finger millet contains 9.2% proteins, 1.29% fat,76.32 Carbohydrates, 2.2% minerals. 3.90% ash, 0.33% calcium. It has been growing for time immemorial as a dual purpose crop where crop production and and animal husbandry go hand in finger millet health benefits epidemiological studies indicated that regular consumption of whole grain can protect against the risk cardio-vascular diseases. Micronutrients are essential for plant growth and play important role in balanced crop nutrition. Foliar application of Micro nutrient sprays prove to best achieve higher yields (savithri, *et al.*, 1999) [8] Sustaining the supply of deficient micronutrients in appropriate amount and right proportion is a key to maximize productivity. (Shankar *al et.*, 2018) [11] Micronutrient plays important role in balanced crop nutrition. As primary and secondary nutrients they play major important role in plant growth like protein synthesis, improving seed quality cell division and pollen tube growth

Materials and Methods
The experiment was conducted during the *Kharif* season of 2020 at the Crop Research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayaraj. The Crop Research Farm is situated at 250 57' N latitude, 870 19' E longitudes and at an altitude of 98 m above mean sea level. This area is situated on the proper side of the river Yamuna and by the other side of Allahabad City. All the facilities

required for crop cultivation were available. The field trail was randomized block design with consisted of 10 treatments replicated thrice viz., T1: control (RDF), T2: 0.2% Zincsulphate + control, T3: 0.2% Zincsulphate + 0.2ferroussulphate, T4: 0.2% Zincsulphate + 0.5 þrroussulphate,T5: 0.4% Zincsulphate + control, T6: 0.4% Zincsulphate + 0.5 þrroussulphate,T7 0.4% Zincsulphate + 0.5 þrroussulphate,T8: 0.6% Zincsulphate + control, T9: 0.6% Zincsulphate + 0.2 ferroussulphate, T10: 0.6% Zinc sulphate + 05 ferrous sulphate. Finger millet was sown at the spacing of 22.5cm×8cm using a seed rate of 10kg/ha. Iron and Zinc are given in the form of (ferrous sulphate and zinc sulphate) through foliar application at intervals of 20,40 and 60DAS Finger millet variety MR-1 was used during *kharif* season 2020.The Recommended dose of fertilizer is 60:30:30kg/ha NPK. Recommended dose of fertilizer was applied at the time of sowing in the form of urea, DAP, MOP. The growth parameters were recorded at periodic intervals 20, 40, 60, 80, 100 DAS and at harvest from randomly selected plants from each treatment.

Chemical analysis of soil

Composite soil samples are collected before layout of the experiment to determine the initial soil properties. The soil samples are collected from 0-15 cm depth and were dried under shade, powdered with wooden pestle and mortar, passed through 2 mm sieve and were analyzed for organic carbon by rapid titration method by Nelson (1975) [6]. Available nitrogen was estimated by alkaline permanganate method by Subbiah and Asija (1956) [9], available phophorus by Olsen's method as outlined by Jackson (1967) [5], available potassium was determined by using the flame photometer normal ammonium acetate solution and estimating by using flame photometer (ELICO Model) as outlined by Jackson (1973) [5] and available $ZnSO_4$ was estimated by Atomic Absorption Spectrophotometer method as outlined by Lindsay and Norvell (1978).

Statistical analysis

The data recorded were different characteristics were subjected to statistical analysis by adopting Fishers the method of analysis of variance (ANOVA) as described by Gomez and Gomez (2010). Critical difference (CD) values were calculated the 'F' test was found significant at 5% level

Result and Discussion

Grain and stover yield varied considerably significant due to various Maximum seed yield was obtained with application of 0.6% Zinc sulphate + 0.5% Ferrous sulphate (3.93 t/ha), which was significantly superior over rest of all the treatments except with application of 0.6% Zinc sulphate + 0.2% Ferrous sulphate (3.84 t/ha) whereas significantly higher stover yield was obtained with application of 0.6% Zinc sulphate + 0.5% Ferrous sulphate (6.03 t/ha), which was superior over rest of all the treatments except with application of 0.6% Zinc sulphate + 0.2% Ferrous sulphate (5.90 t/ha). Increase in all grain yield parameters and straw yield when Zn and Fe were sprayed on foliage at tillering stage in finger millet. Foliar application with micronutrients (Fe, B and Zn) could be thanks to their critical role in crop growth, involving in photosynthesis processes, respiration and other biochemical and physiological activates and thus their importance in achieving higher yields reported by Zeidan *et al., (*2010) [12]. Higher gross returns (INR 87573.33), net return (INR 56639.8) and benefit cost ratio (B:C 1.83) was obtained with foliar application of 0.6% Zinc sulphate + 0.5% Ferrous sulphate, which was significantly superior over rest of the treatments ,this was attributed to the lower cost of cultivation compared to other treatments , highest seed yield is also a factor that influence the economics ,This results are in conformity with the findings of Arjun Sharma *et al.,* (2007) The significant increase in yield and yield attributes due to foliar application of zinc sulphate and iron sulphate might be due to increase seed weight.

Conclusion

The present study clearly showed that the foliar application of 0.6% $ZnSO_4$+0.5$FeSO_4$ this leads to higher yield components and higher gross returns This may due to Zn and Fe are part of photosynthesis from source head to sink. Activates enzymes responsible for proteins. Balanced supply of nutrients are through foliar application is done.

Table 1: Effect of foliar application of iron and zinc on yield of finger millet

Treatments	Seed yield (t/ha)	Stover yield (t/ha)
T_1: Control (RDF)	3.27	5.47
T_2:0.2% Zinc sulphate + control	3.37	5.33
T_3: 0.2% Zinc sulphate + 0.2% Ferrous sulphate	3.51	5.53
T_4: 0.2% Zinc sulphate + 0.5% Ferrous sulphate	3.57	5.63
T_5: 0.4% Zinc sulphate + control	3.53	5.64
T_6: 0.4% Zinc sulphate + 0.2% Ferrous sulphate	3.70	5.76
T_7: 0.4% Zinc sulphate + 0.5% Ferrous sulphate	3.67	5.77
T_8: 0.6% Zinc sulphate + control	3.44	5.56
T_9: 0.6% Zinc sulphate + 0.2% Ferrous sulphate	3.84	5.90
T_{10}: 0.6% Zinc sulphate + 0.5% Ferrous sulphate	3.93	6.03
SEm (±)	0.05	0.05
CD (P=0.05)	0.17	0.16

Table 2: Effect of foliar application of iron and zinc on economics of finger millet

Treatments	Cost of cultivation INR/ha	Gross returns INR/ha	Net returns INR/ha	B:C
T_1: Control (RDF)	28640.00	73666.67	45026.66	1.57
T_2:0.2% Zinc sulphate + control	30782.00	75328.33	44546.33	1.44
T_3: 0.2% Zinc sulphate + 0.2% Ferrous sulphate	30809..00	78423.33	47614.33	1.54
T_4: 0.2% Zinc sulphate + 0.5% Ferrous sulphate	30849.00	79850	49001.00	1.54
T_5: 0.4% Zinc sulphate + control	30824.00	79131.67	48307.66	1.58
T_6: 0.4% Zinc sulphate + 0.2% Ferrous sulphate	30851.00	82640	5179.00	1.68
T_7: 0.4% Zinc sulphate + 0.5% Ferrous sulphate	308915.00	81983.33	51091.83	1.67
T_8: 0.6% Zinc sulphate + control	30866.00	77140	46274.00	1.49
T_9: 0.6% Zinc sulphate + 0.2% Ferrous sulphate	30893.00	85721.67	54828.66	1.77
T_{10}: 0.6% Zinc sulphate + 0.5% Ferrous sulphate	30833.05	87573.33	56639.83	1.83

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