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Agnesh

M.Sc. Scholar, Department of Agronomy, College of Agriculture, Raichur, University of Agricultural Sciences, Raichur, Karnataka, India

Mohan Chavan

Professor and Head, Agricultural Extension Education Centre, Bheemaranagudi, University of Agricultural Sciences, Raichur, Karnataka, India

KA Hiremath

Professor and Head, Department of Agronomy, College of Agriculture, Bheemaranagudi, University of Agricultural Sciences, Raichur, Karnataka, India

Shyamrao Kulkarni

Associate Professor, Department of Agronomy, College of Agriculture, Bheemaranagudi, University of Agricultural Sciences, Raichur, Karnataka, India

Raja

Assistant Professor and Head, Department of Plant Pathology, College of Agriculture, Bheemaranagudi, University of Agricultural Sciences, Raichur, Karnataka, India

Srikant Ullagadde

M.Sc. Scholar, Department of Agronomy, College of Agriculture, Vijayapura, University of Agricultural Sciences, Dharwad, Karnataka, India

Corresponding Author: Agnesh

M.Sc. Scholar, Department of Agronomy, College of Agriculture, Raichur, University of Agricultural Sciences, Raichur, Karnataka, India

Response of foxtail millet (*Setaria italica* L.) to agronomic biofortification with zinc and iron: growth, yield and nutrient uptake

Agnesh¹, Mohan Chavan², KA Hiremath³, Shyamrao Kulkarni⁴, Raja⁵, Srikant Ullagadde⁶

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ABSTRACT

A field study was conducted during Rabi 2025-26 at the College of Agriculture, Bheemaranagudi, UAS, Raichur, to evaluate the response of foxtail millet to agronomic biofortification with zinc and iron on growth, yield and nutrient uptake. The experiment was laid out in an Randomized Complete Block Design with 09 treatments replicated thrice. Results showed that soil application of ZnSO₄ and FeSO₄ @ 5 kg ha⁻¹ each at sowing + foliar spray of ZnSO₄ and FeSO₄ @ 0.5 % each at 40 DAS along with RDF recorded significantly higher growth parameters viz., plant height (144.6 cm), number of tillers (50), leaf area (360.9 cm² plant⁻¹), total dry matter production and its accumulation (12.8 g plant⁻¹) at harvest, yield parameters viz., ear head length (19.9 cm), ear head weight plant⁻¹ (8.8 g), number of ear heads meter⁻¹ (36.0), number of productive tillers meter⁻¹ (45.9), grain yield (2047 kg ha⁻¹) and straw yield (5106 kg ha⁻¹) and also nutrient uptake viz., Zn and Fe (0.30 and 4.48 kg ha⁻¹, respectively), while it was found on par with soil application of ZnSO₄ and FeSO₄ @ 2.5 kg ha⁻¹ each at sowing + foliar spray of ZnSO₄ and FeSO₄ @ 0.25 % each at 40 DAS along with RDF (136.5 cm, 48.7, 351.1 cm² plant⁻¹, 18 cm, 7.8 g, 34.7, 44.5, 1960 kg ha⁻¹, 4829 kg ha⁻¹, 0.26 kg ha⁻¹ and 4.21 kg ha⁻¹ respectively). While, significantly lower growth, yield, yield parameters and nutrient uptake were recorded in control (only RDF).

Keywords: Agronomic biofortification, FeSO₄, ZnSO₄, Foxtail millet, Dry matter, Nutrient uptake

Introduction

Millets are climate-resilient, nutrient-rich cereals well adapted to arid and semi-arid environments and low-input farming systems. Their short duration, low water requirement, efficient nutrient use and adaptability to marginal soil conditions make them important for sustainable food production under changing climates. They are rich in carbohydrates, protein, dietary fibre and essential minerals such as iron (Fe), zinc (Zn), calcium and magnesium, and are therefore recognized as “nutri-cereals” (Saleh *et al.*, 2013) [1]. Among small millets, foxtail millet (*Setaria italica* L.) is an ancient, short-duration C₄ cereal with high photosynthetic efficiency and good adaptation to moisture-limited environments. However, its productivity remains relatively low under many production systems, indicating the need for improved nutrient-management practices.

In India, millets play an important role in dryland agriculture and contribute to food and nutritional security. The country has approximately 12.19 million ha under millets, producing 15.38 million tonnes with an average productivity of 1.26 t ha⁻¹ (Anon., 2024) [2]. In Karnataka, foxtail millet is cultivated mainly under rain-fed and resource-constrained conditions, covering about 9,000 ha with a production of 12,141 tonnes and productivity of 1,349 kg ha⁻¹ (Anon., 2023) [3]. Improving productivity while maintaining grain nutritional quality is therefore important.

Micronutrient deficiencies, particularly Zn and Fe, are major constraints to crop productivity and human nutrition. Zinc is involved in enzyme activation, protein synthesis and growth regulation, whereas Fe plays an essential role in chlorophyll formation, photosynthesis and respiration. Nearly half of the world's cereal-growing soils are reported to have inadequate plant-available Zn (Cakmak, 2008) [4], while Fe availability is often restricted in alkaline and calcareous soils.

Agronomic biofortification through Zn and Fe fertilization provides a practical approach to improve micronutrient availability, uptake and grain enrichment. Soil application can provide sustained nutrient availability, while foliar application enhances nutrient absorption during critical crop stages (Sathisha *et al.*, 2019) [5]. Therefore, the present study was undertaken to evaluate the effect of agronomic biofortification with Zn and Fe on growth, yield attributes, grain yield, straw yield and nutrient uptake of foxtail millet, with the aim of identifying an effective nutrient-management strategy for enhancing crop productivity under arid and semi-arid conditions.

Material and Methods

The experiment was conducted at the Experimental Block of College of Agriculture, Bheemaranagudi, (UAS, Raichur) which lies in the North Eastern Dry Zone of *Karnataka* (Zone-II). It is located at 16°15' N latitude, 77°21' E longitude and at an elevation of 389 meters above mean sea level. The region receives on an average of 630-800 mm rainfall annually. Before sowing, the surface soil samples (0-15 cm depth) were collected using auger from various spots to form one composite soil sample for initial soil fertility evaluation and analyzed by following the standard laboratory procedures (Table 1). The experimental soil was slightly alkaline in reaction with an electrical conductivity (1:2.5 soil:water) of 0.18 dS m⁻¹, medium in available nitrogen, low in available phosphorus, high in potassium and low in DTPA extractable Zn and Fe in soil.

The experiment design followed was randomized complete block design (RCBD) with nine treatment combinations and three replications viz., T₁: Control, T₂: Soil application of ZnSO₄ @ 5 kg ha⁻¹, T₃: Soil application of FeSO₄ @ 5 kg ha⁻¹, T₄: Soil application of ZnSO₄ and FeSO₄ @ 5 kg ha⁻¹ each, T₅: Foliar spray of ZnSO₄ @ 0.5 % at 40 DAS, T₆: Foliar spray of FeSO₄ @ 0.5 % at 40 DAS, T₇: Foliar spray of ZnSO₄ and FeSO₄ @ 0.5 % each at 40 DAS, T₈: Soil application of ZnSO₄ and FeSO₄ @ 2.5 kg ha⁻¹ each + Foliar spray of ZnSO₄ and FeSO₄ @ 0.25 % each at 40 DAS, T₉: Soil application of ZnSO₄ and FeSO₄ @ 5 kg ha⁻¹ each + Foliar spray of ZnSO₄ and FeSO₄ @ 0.5 % each at 40 DAS.

Foxtail millet variety HN-46, recommended for Zones I to III of *Karnataka*, was sown at 30 × 10 cm spacing in gross and net plot sizes of 4.8 × 3.6 m and 3.6 × 3.2 m, respectively. The crop was sown on 5th November 2025 and harvested at physiological maturity on 28th January 2026. Recommended FYM (6 t ha⁻¹) and NPK (30:15:15 kg ha⁻¹) were applied, while ZnSO₄ and FeSO₄ were applied through soil and foliar methods as per the treatments. Soil application was done at sowing, whereas foliar sprays were applied at 40 DAS using a knapsack sprayer with 500 l ha⁻¹ spray volume. The FeSO₄ solution was appropriately neutralized before spraying to minimize leaf scorching. Standard agronomic practices, including protective irrigation, manual weeding and plant protection measures, were followed throughout the crop period. The experimental data were statistically analyzed following the procedure suggested by Panse *et al.* (1967) [6].

Results and Discussion

Growth parameters

Plant height (cm)

At harvest, the combined soil application of ZnSO₄ and FeSO₄ @ 5 kg ha⁻¹ each + foliar spray of ZnSO₄ and FeSO₄ @ 0.5 % each at 40 DAS recorded significantly higher plant height (144.6 cm). This treatment was statistically on par with soil application of ZnSO₄ and FeSO₄ @ 2.5 kg ha⁻¹ each + foliar spray of ZnSO₄ and FeSO₄ @ 0.25 % each at 40 DAS (136.5 cm) and foliar spray of ZnSO₄ and FeSO₄ @ 0.5 % each at 40 DAS (134.7 cm). The control recorded the lower plant height (91.6 cm) and was significantly inferior to all nutrient-applied treatments. The increase in plant height with ZnSO₄ and FeSO₄ application may be attributed to their vital roles in plant metabolism. Zinc promotes tryptophan and indole-3-acetic acid (IAA) synthesis, enhancing cell division and elongation, while activating several enzymes involved in protein and carbohydrate metabolism. Iron is essential for chlorophyll synthesis, respiration and electron transport, leading to improved photosynthetic efficiency. Similar results were reported by White *et al.* (2009) [7] in biofortification of cereals (Table 2).

Leaf area (cm² plant⁻¹)

At harvest, a reduction in leaf area was observed across all treatments owing to the natural senescence of older leaves. However, soil application of ZnSO₄ and FeSO₄ @ 5 kg ha⁻¹ each + foliar spray of ZnSO₄ and FeSO₄ @ 0.5 % each at 40 DAS maintained significantly higher leaf area (360.9 cm² plant⁻¹) and it was found statistically on par with soil application of ZnSO₄ and FeSO₄ @ 2.5 kg ha⁻¹ each + foliar spray of ZnSO₄ and FeSO₄ @ 0.25 % each at 40 DAS (351.1 cm² plant⁻¹), foliar spray of ZnSO₄ and FeSO₄ @ 0.5 % each at 40 DAS (343.4 cm² plant⁻¹) and soil application of ZnSO₄ and FeSO₄ @ 5 kg ha⁻¹ each (336.7 cm² plant⁻¹). Significantly lower leaf area was recorded in control (282.5 cm² plant⁻¹). The lower leaf area in the control may be attributed to inadequate Zn and Fe supply, limiting enzyme activity, chlorophyll formation and photosynthetic efficiency. Balanced Zn and Fe nutrition enhanced leaf initiation and expansion, increasing the photosynthetic surface and thereby promoting biomass accumulation. These observations are in agreement with reports on agronomic biofortification of cereals and foxtail millet, White *et al.* (2009) [7].

Table 1. Initial chemical properties of experimental site and grain

Particulars	Value obtained	Method	Reference
Soil pH (1:2.5 ratio of soil and water)	8.20	Potentiometry	Jackson, 1973
Electrical conductivity (dS m ⁻¹)	0.18	Conductometry	Jackson, 1973
Organic carbon (%)	0.48	Wet oxidation method	Walkley and Black, 1934
Available N (kg ha ⁻¹)	363.80	Alkaline permanganate method	Subbiah and Asija, 1956
Available P ₂ O ₅ (kg ha ⁻¹)	19.00	Olsen's extractant method	Jackson, 1973
Available K ₂ O (kg ha ⁻¹)	369.90	Flame photometer	Jackson, 1973
DTPA extractable Zn (ppm)	0.32	Atomic absorption spectrophotometry	Lindsay and Norvell, 1978
DTPA extractable Fe (ppm)	4.18	Atomic absorption spectrophotometry	Lindsay and Norvell, 1978
Zinc content in grain (ppm)	22.16	Atomic absorption spectrophotometry	Lindsay and Norvell, 1978
Iron content in grain (ppm)	560.28	Atomic absorption spectrophotometry	Lindsay and Norvell, 1978

(continued on next page)

Total dry matter production (g plant^{-1})

At harvest treatment receiving soil application of ZnSO_4 and FeSO_4 @ 5 kg ha^{-1} each + foliar spray of ZnSO_4 and FeSO_4 @ 0.5 % each at 40 DAS recorded significantly higher total dry matter production ($12.88 \text{ g plant}^{-1}$), which was statistically on par with soil application of ZnSO_4 and FeSO_4 @ 2.5 kg ha^{-1} each + foliar spray of ZnSO_4 and FeSO_4 @ 0.25 % each at 40 DAS ($12.16 \text{ g plant}^{-1}$). The control was recorded significantly lower total dry matter production ($7.98 \text{ g plant}^{-1}$) among all the treatments. Overall, the combined soil and foliar application of Zn and Fe enhanced dry matter accumulation by improving enzymatic activity, chlorophyll synthesis, photosynthesis, nutrient uptake and assimilate partitioning. This vigorous biomass production contributed to improved grain yield and nutrient accumulation in foxtail millet. Similar results were reported by White *et al.* (2009) [7] and Krupashree *et al.* (2022) [8] in biofortification of ZnSO_4 and FeSO_4 in foxtail millet in organic condition (Table 2 and Figure 1).

Yield and yield parameters

Economic yield is the cumulative result of physiological and biochemical processes during crop growth, influenced by plant morphology, biomass accumulation and assimilate partitioning. Adequate and balanced availability of resources, particularly Zn and Fe, plays a vital role in improving yield attributes and overall crop productivity. The results revealed significant differences among the treatments with respect to yield and yield attributes, namely ear head length (cm), ear head weight per plant (g), number of ear heads per meter, grain yield (kg ha^{-1}) and straw yield (kg ha^{-1}). These variations were brought about by effect of the agronomic biofortification of zinc and iron. The detailed results were presented in Table 2 and Figure 2.

Length of ear head (cm)

The treatment receiving soil application of ZnSO_4 and FeSO_4 @ 5 kg ha^{-1} each + foliar spray of ZnSO_4 and FeSO_4 @ 0.5 % each at 40 DAS recorded significantly higher ear head length (19.9 cm), which was statistically on par with soil application of ZnSO_4 and FeSO_4 @ 2.5 kg ha^{-1} each + foliar spray of ZnSO_4 and FeSO_4 @ 0.25 % each at 40 DAS (18.0 cm). Whereas, the control was recorded significantly lower ear head length (15.5 cm). The increased ear head length recorded in the present study may be attributed to the synergistic effects of Zn and Fe in stimulating auxin synthesis, enzyme activation, chlorophyll formation, photosynthetic efficiency and assimilate translocation towards reproductive organs. These physiological improvements promote better panicle elongation, increase the sink capacity of the crop and ultimately contribute to higher grain yield and productivity of foxtail millet. Similar results founded by Qureshi *et al.* (2021) [9] and Krupashree *et al.* (2022) [8].

Number of ear heads m^{-1}

Among different treatments, soil application of ZnSO_4 and FeSO_4 @ 5 kg ha^{-1} each + foliar spray of ZnSO_4 and FeSO_4 @ 0.5 % each at 40 DAS recorded significantly higher number of ear heads (36.0 m^{-1}), while it remained statistically on par with soil application of ZnSO_4 and FeSO_4 @ 2.5 kg ha^{-1} each + foliar spray of ZnSO_4 and FeSO_4 @ 0.25 % each at 40 DAS (34.7 m^{-1}) and foliar spray of ZnSO_4 and FeSO_4 @ 0.5 % each at 40 DAS (34.0 m^{-1}). Whereas, control was recorded significantly lower number of ear heads (18.9 m^{-1}). The increased number of ear heads m^{-1} under combined soil and foliar Zn and Fe application was attributed to enhanced tiller production, survival of productive tillers and improved reproductive development. Zn promotes auxin synthesis, enzyme activity and meristematic growth, while Fe enhances chlorophyll synthesis, photosynthesis and energy metabolism, thereby improving assimilate production and source-sink relationships. Similar improvements in growth and yield attributes of foxtail millet under Zn and Fe nutrition were reported by Krupashree *et al.* (2022) [8]. The physiological basis of these responses is further supported by White *et al.* (2009) [7] and Qureshi *et al.* (2021) [9], who reported enhanced crop growth and productivity following agronomic biofortification with Zn and Fe.

Ear head weight (g plant^{-1})

Among different treatments, soil application of ZnSO_4 and FeSO_4 @ 5 kg ha^{-1} each + foliar spray of ZnSO_4 and FeSO_4 @ 0.5 % each at 40 DAS recorded significantly higher ear head weight (8.8 g plant^{-1}). While, the control recorded the significantly lower ear head weight (5.8 g plant^{-1}). Remaining treatments recorded intermediate values. The increased ear head weight under combined soil and foliar application of Zn and Fe may be attributed to enhanced photosynthesis, assimilate production and translocation to developing ear heads. Zinc promotes enzyme activity, auxin synthesis and reproductive development, while iron supports chlorophyll synthesis, electron transport and energy metabolism. Their balanced supply may improve biomass accumulation, grain filling and source-sink balance, resulting in heavier ear heads. This is supported by the physiological mechanisms reported by White *et al.* (2009) [7].

Number of productive tillers (m^{-1})

The combined soil and foliar application of ZnSO_4 and FeSO_4 produced the higher conversion of tillers into productive tillers. Soil application of ZnSO_4 and FeSO_4 @ 5 kg ha^{-1} each + foliar spray of ZnSO_4 and FeSO_4 @ 0.5 % each at 40 DAS recorded significantly higher number of productive tillers (45.9 m^{-1}), followed by soil application of ZnSO_4 and FeSO_4 @ 2.5 kg ha^{-1} each + foliar spray of ZnSO_4 and FeSO_4 @ 0.25 % each at 40 DAS, with 44.5 productive tillers m^{-1} . Control recorded significantly lower number of productive tillers (21.8 m^{-1}). The balanced availability of Zn and Fe also enhances nutrient uptake and dry matter accumulation, resulting in a greater number of productive tillers. Similar improvement was reported in foxtail millet under Zn and Fe nutrition through enriched organics by Krupashree *et al.* (2022) [8].

Grain yield (kg ha^{-1})

Among the different agronomic biofortification treatments, soil application of ZnSO_4 and FeSO_4 @ 5 kg ha^{-1} each + foliar spray of ZnSO_4 and FeSO_4 @ 0.5 % each at 40 DAS recorded significantly higher grain yield (2047 kg ha^{-1}) which was 19.8 % higher grain yield than the control however it was found statistically on par with soil application of ZnSO_4 and FeSO_4 @ 2.5 kg ha^{-1} each + foliar spray of ZnSO_4 and FeSO_4 @ 0.25 % each at 40 DAS (1960 kg ha^{-1}) and foliar spray of ZnSO_4 and FeSO_4 @ 0.5 % each at 40 DAS (1864 kg ha^{-1}). The lower grain yield was recorded in the control (1709 kg ha^{-1}).

Straw yield (kg ha^{-1})

A similar trend was observed in straw yield as that of grain yield. The treatment receiving soil application of ZnSO_4 and FeSO_4 @ 5 kg ha^{-1} each + foliar spray of ZnSO_4 and FeSO_4 @ 0.5 % each at 40 DAS recorded significantly higher straw yield (5106 kg ha^{-1}) and it was found statistically on par with soil application ZnSO_4 and FeSO_4 @ 2.5 kg ha^{-1} each + foliar spray of ZnSO_4 and FeSO_4 @ 0.25 % each at 40 DAS (4829 kg ha^{-1}), whereas significantly lower straw yield was obtained in the control (4290 kg ha^{-1}).

The significant improvement in yield and yield attributes such as ear head length, ear head weight per plant, number of ear heads per meter, grain yield and straw yield under zinc and iron biofortification of foxtail millet may be attributed to the complementary physiological roles of these micronutrients in enhancing plant growth, photosynthetic efficiency, nutrient utilization and assimilate translocation. Zinc plays an important role in auxin synthesis, enzyme activation, protein metabolism and pollen development, whereas iron is indispensable for chlorophyll synthesis, electron transport and energy generation during photosynthesis. Adequate availability of both micronutrients promotes vigorous vegetative growth, efficient carbohydrate production and effective partitioning of assimilates towards reproductive sinks, thereby improving grain formation and final yield. Similar results quoted by White *et al.* (2009) [7], Yadav *et al.* (2011) [10], Sathisha *et al.* (2019) [5] and Krupashree *et al.* (2022) [8] in foxtail millet.

Nutrient uptake (kg ha^{-1})

With respect to nutrient uptake soil application of ZnSO_4 and FeSO_4 @ 5 kg ha^{-1} each sowing + foliar spray of ZnSO_4 and FeSO_4 @ 0.5% each at 40 DAS recorded significantly higher nutrient uptake in grain, straw and total with respect to nitrogen, phosphorus, potassium, zinc and iron [(37.83, 28.21 and $66.04 \text{ kg N ha}^{-1}$), (7.13, 6.91 and $14.04 \text{ kg P}_2\text{O}_5 \text{ ha}^{-1}$), (9.17, 67.62 and $76.78 \text{ kg K}_2\text{O ha}^{-1}$), (0.09, 0.20

and $0.30 \text{ kg Zn ha}^{-1}$) and (1.72, 2.77 and $4.48 \text{ kg Fe ha}^{-1}$), respectively]. Which was found significantly on par with soil application of ZnSO_4 and FeSO_4 @ 2.5 kg ha^{-1} each + foliar spray of ZnSO_4 and FeSO_4 @ 0.25% each at 40 DAS [(34.22, 25.76 and $59.98 \text{ kg N ha}^{-1}$), (6.46, 6.07 and $12.53 \text{ kg P}_2\text{O}_5 \text{ ha}^{-1}$), (8.40, 62.17 and $70.57 \text{ kg K}_2\text{O ha}^{-1}$), (0.09, 0.18 and $0.26 \text{ kg Zn ha}^{-1}$) and (1.63, 2.58 and $4.21 \text{ kg Fe ha}^{-1}$), respectively]. However, significantly lower nutrient uptake was recorded in the control (Table 3 and Figure 3 & 4).

Table 2. Growth, yield and yield parameters of foxtail millet at harvest as influenced by agronomic biofortification of zinc and iron

Treatment	Plant height (cm)	Leaf area ($\text{cm}^2 \text{ plant}^{-1}$)	Total dry matter (g plant^{-1})	Length of ear head (cm)	Number of ear heads m^{-2}	Ear head weight (g plant^{-1})	Number of productive tillers (m^{-2})	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})
T ₁	91.6	282.5	7.9	15.5	18.9	5.8	21.8	1709	4290
T ₂	108.7	297.3	10.0	16.9	23.0	6.7	28.7	1790	4311
T ₃	105.0	286.8	9.30	16.8	20.3	6.3	25.8	1764	4297
T ₄	128.9	336.7	11.7	17.6	31.3	7.4	37.9	1847	4582
T ₅	121.4	314.2	10.4	16.8	29.3	7.1	36.6	1823	4628
T ₆	111.8	300.2	10.1	17.5	27.0	6.7	31.9	1798	4532
T ₇	134.7	343.4	11.6	17.9	34.0	7.5	43.3	1864	4656
T ₈	136.5	351.1	12.1	18.0	34.7	7.8	44.5	1960	4829
T ₉	144.6	360.9	12.8	19.9	36.0	8.8	45.9	2047	5106
S.Em.±	4.7	13.1	0.3	0.6	1.0	0.2	1.6	63	107
C.D. ($P = 0.05$)	14.2	39.2	1.0	1.91	2.9	0.7	4.8	191	322

Note: RDF-30:15:15 kg N:P₂O₅:K₂O ha⁻¹; FYM @ 6 t ha^{-1} is common for all the treatments. Half of N, entire P, K was applied as basal and remaining half of N was top dressed at 30 days after sowing.

DAS: Days After Sowing.

The enhanced uptake of N, P, K, Zn and Fe observed in the present investigation agronomic biofortification of zinc and iron in foxtail millet, explained the improvement in root architecture and nutrient use efficiency. Zinc enhances membrane integrity and root proliferation, facilitating greater exploration of soil volume for nutrient acquisition, whereas iron promotes energy generation required for active ion uptake and transport within the plant. Increased photosynthetic activity under adequate Fe supply produces more carbohydrates, which stimulate root growth and provide energy for nutrient absorption. Consequently, greater nutrient uptake supports enhanced vegetative growth, biomass accumulation and grain development, leading to higher removal of N, P and K by both grain and straw. Similar results founded by White *et al.* (2009) [7], Qureshi *et al.* (2021) [9] and Krupashree *et al.* (2022) [8].

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Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this article. No funding or sponsorship influenced the design of the study, data collection, analysis, decision to publish, or preparation of the manuscript.

Conclusion

Soil application of ZnSO_4 and FeSO_4 @ 5 kg ha^{-1} each at sowing + foliar spray of ZnSO_4 and FeSO_4 @ 0.5% each at 40 DAS along with the RDF, proved to be the most effective agronomic biofortification strategy in foxtail millet. The treatment enhanced growth, yield attributes and nutrients (N, P, K, Zn and Fe) uptake resulting in higher grain and straw productivity, with a 19 % increase in grain yield over the control. This treatment follows soil application of ZnSO_4 and FeSO_4 @ 2.5 kg ha^{-1} each + foliar spray of ZnSO_4 and FeSO_4 @ 0.25% each at 40 DAS along with the RDF.

Table 3. Nutrient uptake (kg ha^{-1}) by foxtail millet as influenced by agronomic biofortification of zinc and iron

Treatment	Nitrogen uptake (kg ha^{-1})			Phosphorus uptake (kg ha^{-1})			Potassium uptake (kg ha^{-1})			Zinc uptake (kg ha^{-1})			Iron uptake (kg ha^{-1})		
	Grain	Straw	Total	Grain	Straw	Total	Grain	Straw	Total	Grain	Straw	Total	Grain	Straw	Total
T ₁	24.81	17.15	41.96	4.21	3.43	7.64	5.98	47.27	53.22	0.04	0.07	0.12	1.19	1.25	2.44
T ₂	27.66	19.65	47.31	4.94	3.87	8.81	6.82	50.70	57.52	0.06	0.13	0.19	1.30	1.42	2.72
T ₃	26.89	18.94	45.83	4.77	3.87	8.65	6.53	50.05	56.58	0.04	0.08	0.13	1.30	2.19	3.49
T ₄	30.40	22.11	52.51	5.54	5.48	11.02	7.32	55.71	63.03	0.07	0.16	0.23	1.51	2.39	3.90
T ₅	28.89	21.37	50.26	5.12	4.18	9.29	7.13	55.44	62.57	0.07	0.14	0.21	1.42	1.65	3.07

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T ₆	27.77	21.01	48.79	5.02	4.65	9.67	6.72	53.28	60.00	0.05	0.09	0.14	1.44	2.34	3.78
T ₇	31.44	22.94	54.38	5.93	4.51	10.43	7.66	57.88	65.53	0.08	0.16	0.24	1.54	2.44	3.98
T ₈	34.22	25.76	59.98	6.46	6.07	12.53	8.40	62.17	70.57	0.09	0.18	0.26	1.63	2.58	4.21
T ₉	37.83	28.21	66.04	7.13	6.91	14.04	9.17	67.62	76.78	0.09	0.20	0.30	1.72	2.77	4.48
S.E.m.±	1.26	1.14	2.05	0.28	0.29	0.49	0.31	2.31	2.38	0.00	0.01	0.01	0.07	0.09	0.13
C.D. (P = 0.05)	3.79	3.43	6.15	0.84	0.87	1.47	0.92	6.93	7.14	0.01	0.02	0.02	0.22	0.28	0.39

Note:

• **RDF-30:15:15** kg N:P₂O₅:K₂O ha⁻¹; FYM @ 6 t ha⁻¹ is common for all the treatments.

• Half of N, entire P, K was applied as basal and remaining half of N was top dressed at 30 days after sowing.

• **DAS:** Days After Sowing.

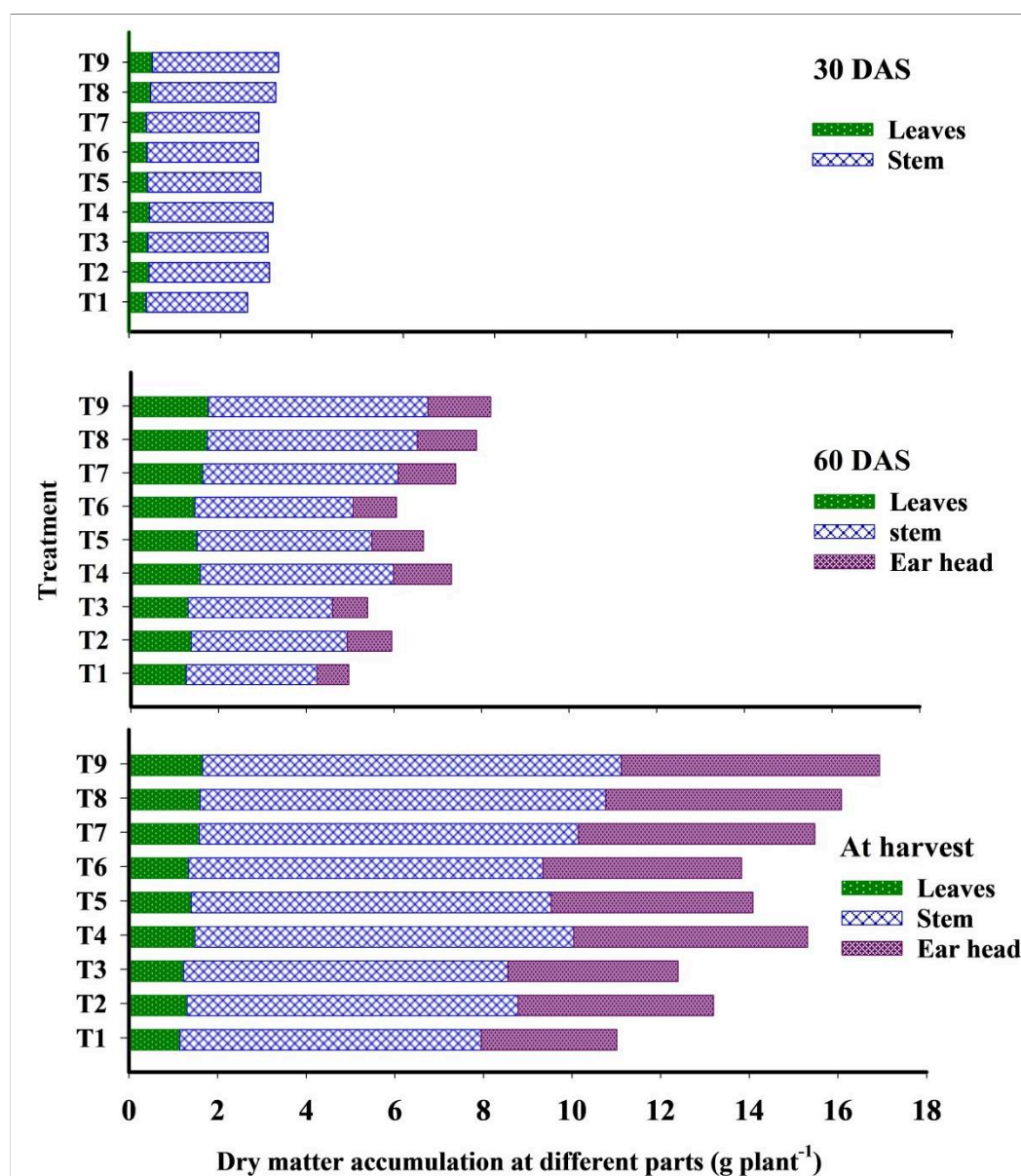


Figure 1. Total dry matter production (g plant⁻¹) at different growth stages of foxtail millet as influenced by agronomic biofortification of zinc and iron in foxtail millet

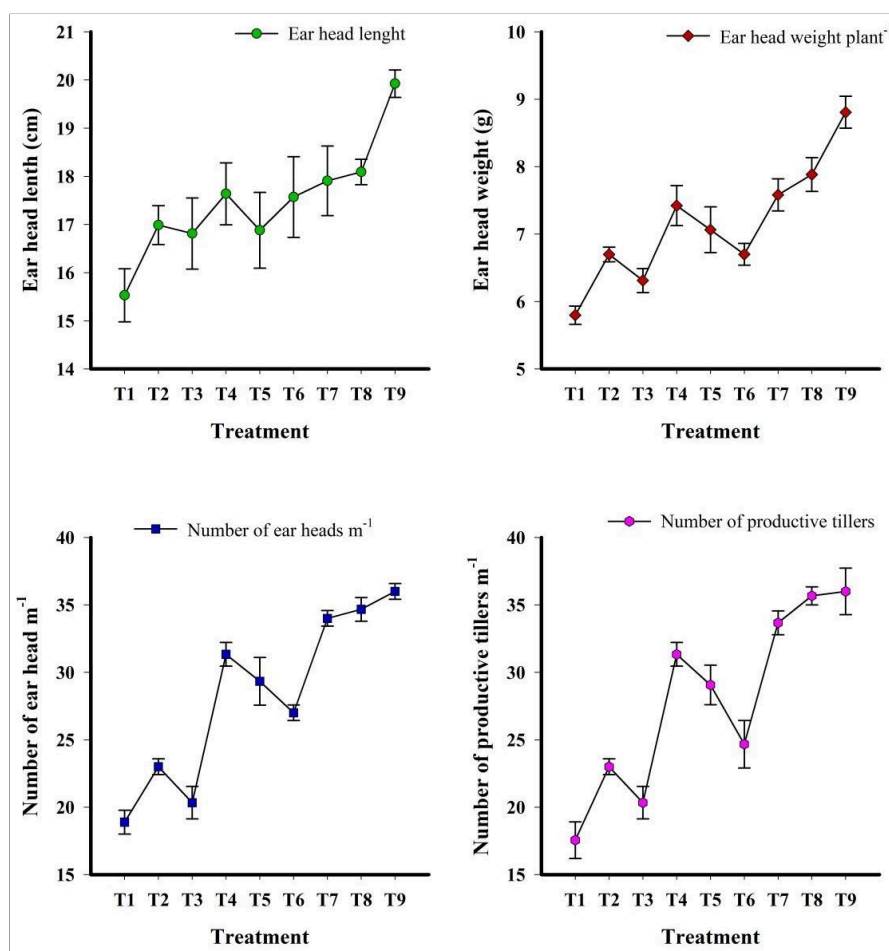


Figure 2. Yield parameters of foxtail millet as influenced by agronomic biofortification of zinc and iron in foxtail millet

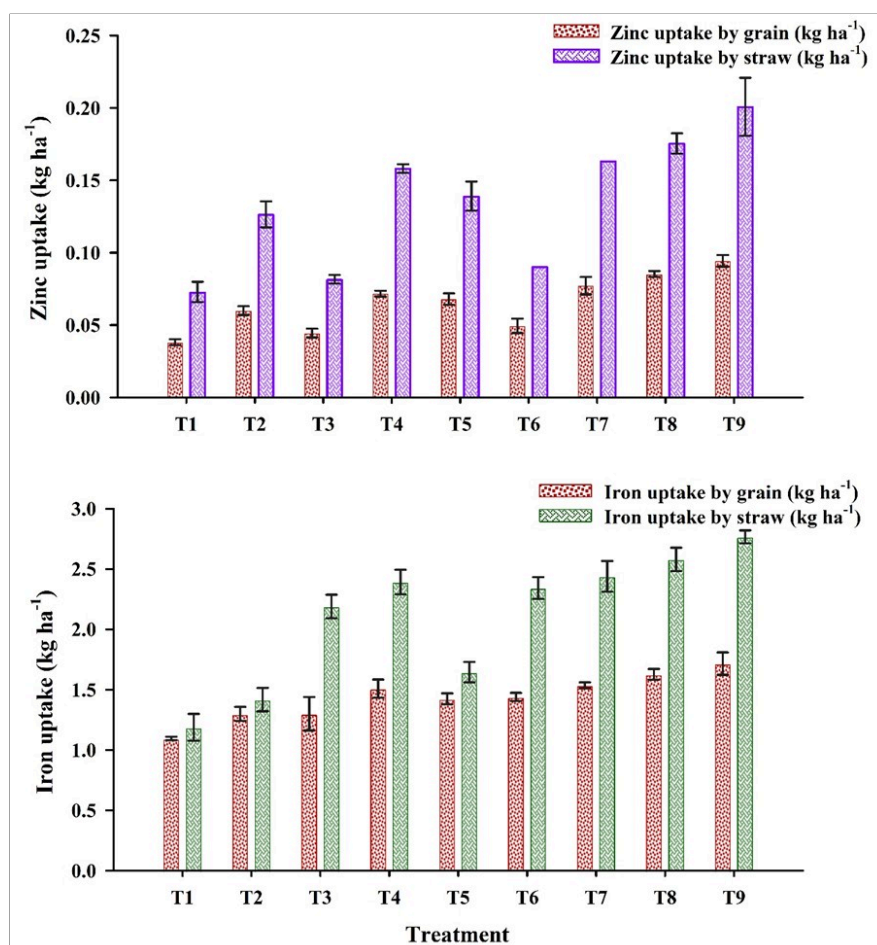


Figure 3. Nitrogen, phosphorus and potassium uptake ($kg\ ha^{-1}$) by foxtail millet as influenced by agronomic biofortification of zinc and iron in foxtail millet

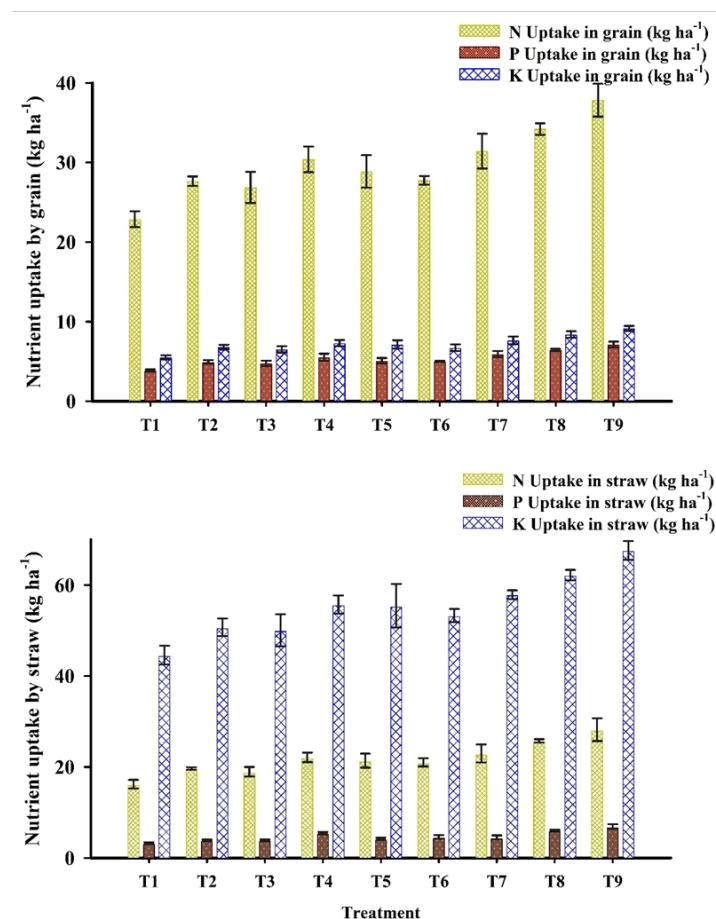


Figure 4. Zinc and iron uptake (kg ha⁻¹) by foxtail millet as influenced by agronomic biofortification of zinc and iron in foxtail millet

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