

Original Research Article

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Grain Quality Parameters as Influenced by Various Sources of Zinc and Iron

E. Ajay Kumar^{1*}, K.Surekha², K. Bhanu Rekha³ and S. Harish Kumar Sharma⁴

¹Department of Soil Science, PJTSAU Rajendranagar, Hyderabad, India

²Department of Soil Science, ICAR-Indian Institute of Rice Research, Hyd-30, India

³Department of Agronomy, College of Agriculture, Rajendranagar, Hyd-30, India

⁴Department of Soil Science, College of Agriculture, Rajendranagar, Hyd-30, India

*Corresponding author

ABSTRACT

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A field experiment was conducted during *Kharif* 2018 at College Farm, College of Agriculture, PJTSAU to evaluate the effect of various sources of zinc and iron on grain quality parameters of finger millet. The experiment was laid out in a randomized block design with 14 treatments and replicated thrice. The results revealed that application of different Zinc and iron sources at different rates significantly influenced the grain quality parameters (protein and calcium content) of finger millet. Highest protein (11.25%) and calcium content (2.33%) in grain were obtained in the treatment receiving RDF + foliar application of FeSO₄ @ 0.5% twice at 30 and 60 DAS which was on par with treatment receiving RDF + foliar application of Fe-humate twice at 30 and 60 DAS (10.90% and 2.0 %) and the lowest (6.25%) and calcium content (1.10 %) were recorded with application of RDF alone. Other than protein and calcium content there was no significant differences between treatments with respect to N, P, K, Zn, Fe, and carbohydrate content

Introduction

Ragi is commonly known as “Nutritious millet” on account of its superiority to many cereals (rice, corn and sorghum) in terms of proteins, minerals, iron, calcium and vitamins in abundance. Finger millet is considered as 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). Finger millet is locally known as ragi and mandua

(India). It is an important staple food in parts of eastern and central Africa and India (Singh and Rita, 2011). Malnutrition and undernourishment are the major problems of Indian population due to which millets are becoming alternate source of human food globally as well as in India. The calcium content in this crop is higher than all other cereals while, the iodine content is said to be highest among all the food grains. Moreover, antioxidant properties, and phytochemicals make it easily and slowly digestible and help to control blood glucose levels in diabetes

patients very efficiently. Ragi has the best quality protein along with the presence of essential amino acids, vitamin A, vitamin B and phosphorus (Gopalan *et al.*, 2004). Besides this, the importance of micronutrients such as zinc and iron in improving the quality of food or value addition also needs to be evaluated to overcome the imbalance of nutrients in the produce. With the changes in scenario of utilization of processed products and awareness among the consumers about the health benefits, finger millet has gained importance on account of its functional components, such as slowly digestible starch and resistant starch (Wadikar *et al.*, 2007). It is reported that during malting process, calcium and phosphorus content increases, whereas iron content decreases (Sangita and Sarita, 2000). Cakmak (2008), concluded that foliar or combined soil and foliar application of zinc fertilizer under field conditions is highly effective and very practical way to maximize 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 (Bhumika and Kalpana, 2010). Iron is an essential plant nutrient required for electron transport in photosynthesis. However, application of iron fertilizers may overcome its deficiency in soil and increase crop yields which will subsequently increase crop productivity and income of the farmers (Vikash *et al.*, 2015).

Materials and Methods

The experiment was carried out during *Kharif* 2018 at College Farm, College of Agriculture, PJTSAU. The experimental site is geographically located at 17°19' N latitude and 78°23' E longitude at an altitude of 542.6

m above mean sea level on Hyderabad-Bangalore National highway. The soil of the experimental site was sandy loam soil which is low in organic carbon (0.42 %), available nitrogen (132 kg ha⁻¹), P₂O₅ (18.13 kg ha⁻¹) and high in K₂O (464.8 kg ha⁻¹). The DTPA extractable zinc (0.3mg kg⁻¹) and iron(3.8mg kg⁻¹) was lower than the critical limit. The soil was slightly non-saline in nature. The experiment was laid out in randomized block design with 14 treatments (as detailed in Table1) and replicated thrice. The gross plot size was 4.5 m × 4.5 m (20.25 m²). Crop (variety GPU-28) was sown by line sowing by adopting a spacing of 30 cm × 15 cm. As the seed was fine it was mixed with sand to ensure optimum population. The recommended dose of fertilizer was 60:40:30 kg N, P₂O₅ and K₂O ha⁻¹. Entire recommended dose of phosphorous and potassium were applied as basal dose in the form of DAP and MOP. Uniform dose of nitrogen was applied through urea in 3 equal splits (1/3rd as basal and 1/3rd at vegetative phase and remaining 1/3rd) at panicle initiation stage to all the plots.

Results and Discussion

Quality parameters

Nitrogen content in grain

There was no significant difference among the treatments though highest nitrogen content in the grain was obtained in the treatment receiving RDF + foliar application of FeSO₄ @ 0.5% twice at 30 and 60 DAS (1.80 %) and the lowest was recorded with application of RDF alone (1.0 %) (Table 2 and Figure 1).

Application of either Fe or Zn significantly increased N, P, Fe and Zn content in grain and straw of rice as compared to control (Patel *et al.*, 2017).

Phosphorus content in grain

There was no significant difference among the treatment and the highest phosphorus content (0.48 %) in grain was noticed in treatment receiving RDF+ foliar application of FeSO₄ @ 0.5% twice at 30 and 60 DAS and lowest was recorded with application of RDF alone (0.30 %). Application of either Fe or Zn significantly increased N, P, Fe and Zn content in grain and straw of rice as compared to control (Patel *et al.*, 2017) (Table 2 and Figure 2).

Potassium content in grain

There was no significant difference among the treatments though highest potassium content (0.68%) in grain was recorded in treatment receiving RDF + foliar application of FeSO₄ @ 0.5% twice at 30 and 60 DAS

and lowest was recorded with application of RDF alone (0.47 %) (Table 2 and Figure 3).

Iron (Fe) content in grain

There was no significant difference among the treatments though highest iron content (160 ppm) in grain was noticed in treatment receiving RDF + foliar application of FeSO₄ @ 0.5% twice at 30 and 60 DAS and lowest was recorded with application of RDF alone (151 ppm). Foliar spray of iron (Fe) and zinc (Zn) fertilizers are known to be an effective way to improve Fe and Zn concentrations in rice grain (Yuan *et al.*, 2012). It can be concluded that the foliar application of zinc and iron fertilizers have positive effect on growth, yield components and grain yield by wheat when plants are not able to absorb the iron and zinc from soil due to high soil pH.

Table.1 Treatment details

S.No.	Treatments	Treatments
1	T ₁	RDF (60-40-30 Kg N-P ₂ O ₅ -K ₂ O ha ⁻¹)
2	T ₂	Vermicompost @ 5.0 t ha ⁻¹ + RDF
3	T ₃	RDF + ZnSO ₄ @ 50 kg ha ⁻¹ soil application
4	T ₄	RDF + ZnSO ₄ @ 0.2% foliar spray twice at 30 and 60 days after sowing
5	T ₅	RDF + Zn-EDTA soil application @ 10 kg ha ⁻¹
6	T ₆	RDF + Zn-EDTA foliar spray @ 0.1 % twice at 30 and 60 days after sowing
7	T ₇	RDF + Zn Humate soil application @ 42 kg ha ⁻¹
8	T ₈	RDF + Zn Humate foliar spray @ 0.25% twice at 30 and 60 days after sowing
9	T ₉	RDF + FeSO ₄ @ 50 kg ha ⁻¹ soil application
10	T ₁₀	RDF + FeSO ₄ @ 0.5% foliar spray twice at 30 and 60 days after sowing
11	T ₁₁	RDF + Fe-EDTA soil application @ 10 kg ha ⁻¹
12	T ₁₂	RDF + Fe-EDTA foliar spray @ 0.1 % twice at 30 and 60 days after sowing
13	T ₁₃	RDF + Fe Humate soil application @ 42 kg ha ⁻¹
14	T ₁₄	RDF + Fe Humate foliar spray @ 0.25 % twice at 30 and 60 days after sowing

Table.2 Effect of zinc and iron nutrition on grain quality parameters of finger millet

Treatments	N content (%)	P content (%)	K content (%)	Protein content (%)	Zinc content (ppm)	Iron content (ppm)	Calcium content (%)	Carbohydrate (%)
T ₁	1.00	0.30	0.47	6.25	14	151	1.10	60
T ₂	1.0	0.32	0.50	6.25	14	152	1.10	61
T ₃	1.02	0.34	0.50	6.38	14	153	1.20	62
T ₄	1.20	0.40	0.59	7.50	19	157	1.60	65
T ₅	1.09	0.39	0.50	6.67	15	155	1.40	64
T ₆	1.60	0.45	0.62	10.0	17	158	1.78	67
T ₇	1.07	0.38	0.53	6.83	16	155	1.44	64
T ₈	1.73	0.45	0.64	10.81	17	158	1.80	67
T ₉	1.18	0.40	0.59	7.38	16	157	1.60	65
T ₁₀	1.80	0.48	0.68	11.25	18	160	2.33	70
T ₁₁	1.03	0.37	0.54	6.44	15	153	1.20	63
T ₁₂	1.23	0.43	0.60	7.71	17	157	1.70	66
T ₁₃	1.17	0.38	0.55	7.29	16	156	1.57	64
T ₁₄	1.74	0.47	0.66	10.90	17	158	2.00	68
S. E m. ±	0.21	0.06	0.06	1.2	1	3	0.14	2
C.D. (0.05)	NS	NS	NS	3.5	NS	NS	0.43	NS

Fig.1 Effect of Zinc and Iron nutrition on N content (%) in grain of finger millet

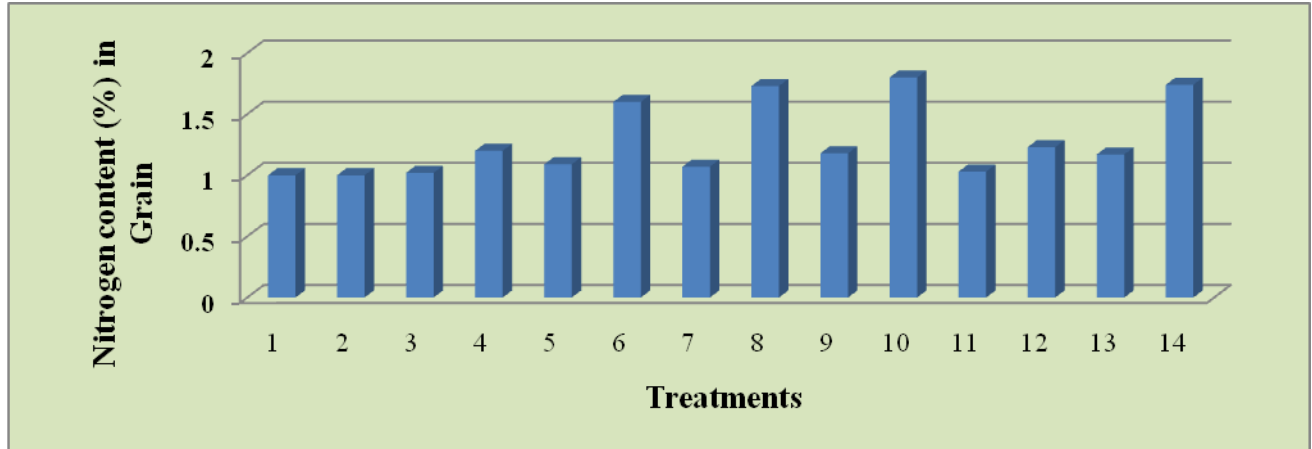


Fig.2 Effect of Zinc and Iron nutrition on P content (%) in grain of finger millet

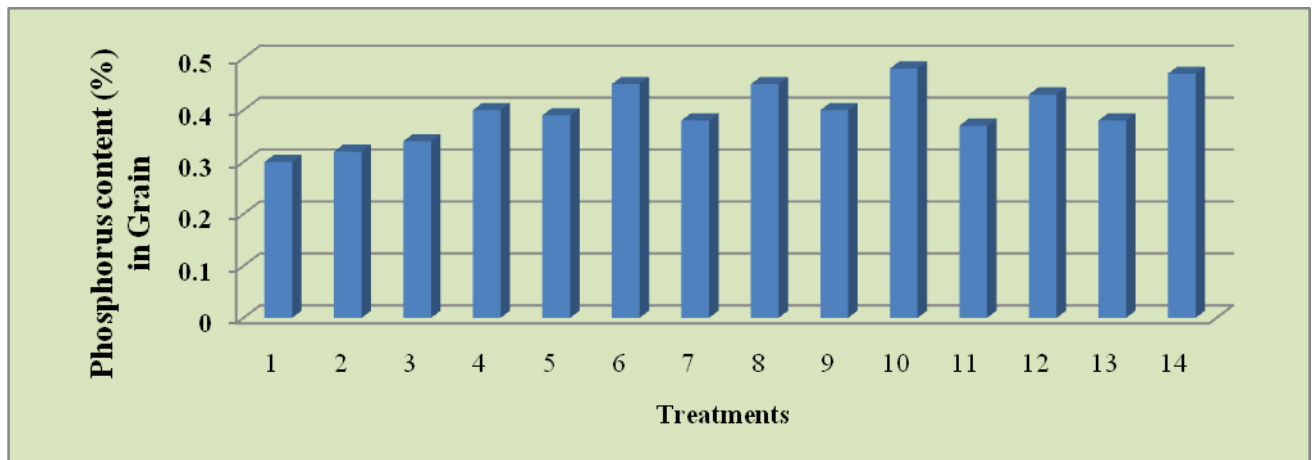


Fig.3 Effect of Zinc and Iron nutrition on K content (%) in grain of finger millet

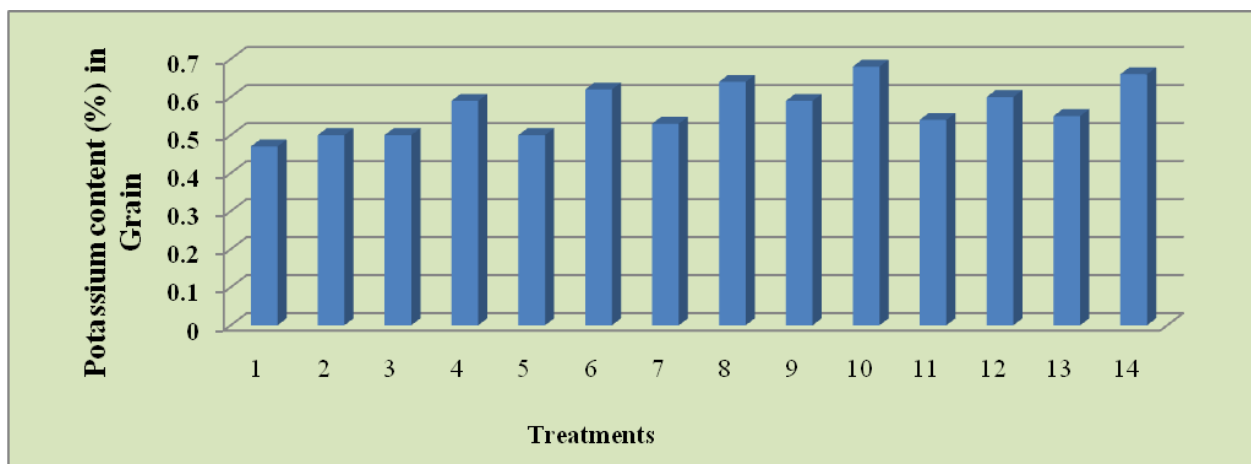


Fig.4 Effect of zinc and iron nutrition on protein content (%) in grain of finger millet.

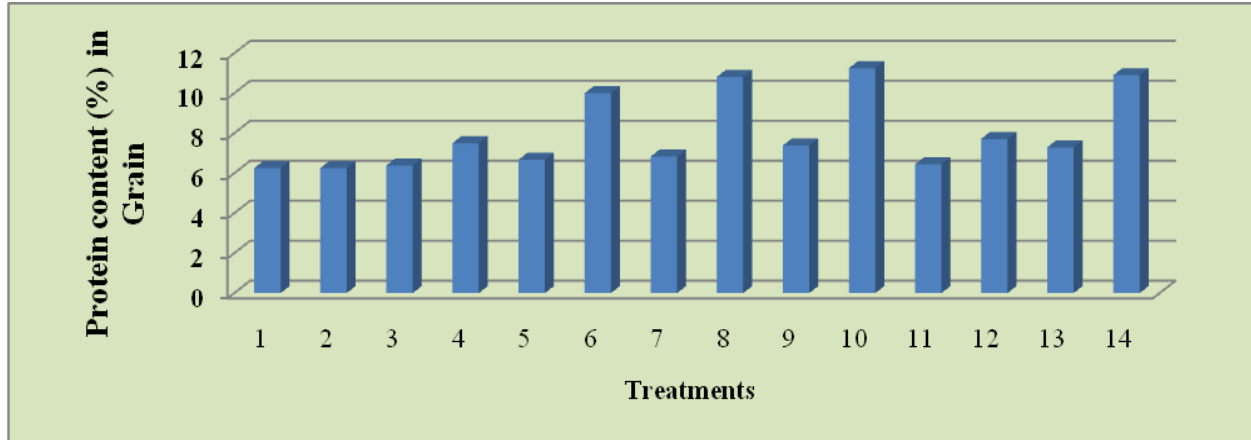


Fig.5 Effect of zinc and iron nutrition on Ca content (%) in grain of finger milles

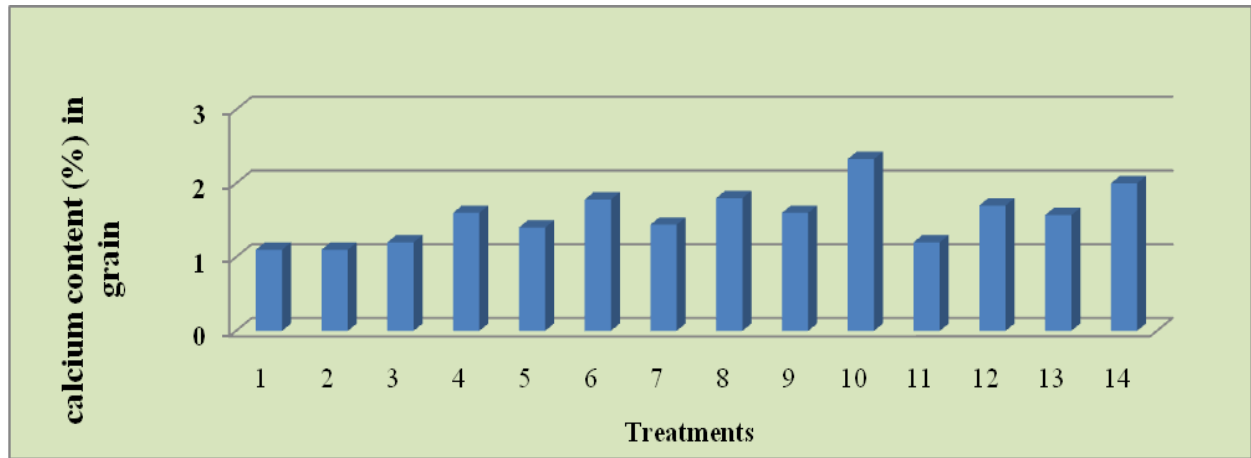


Fig.6 Effect of zinc and iron nutrition on carbohydrate (%) in grain of finger millet

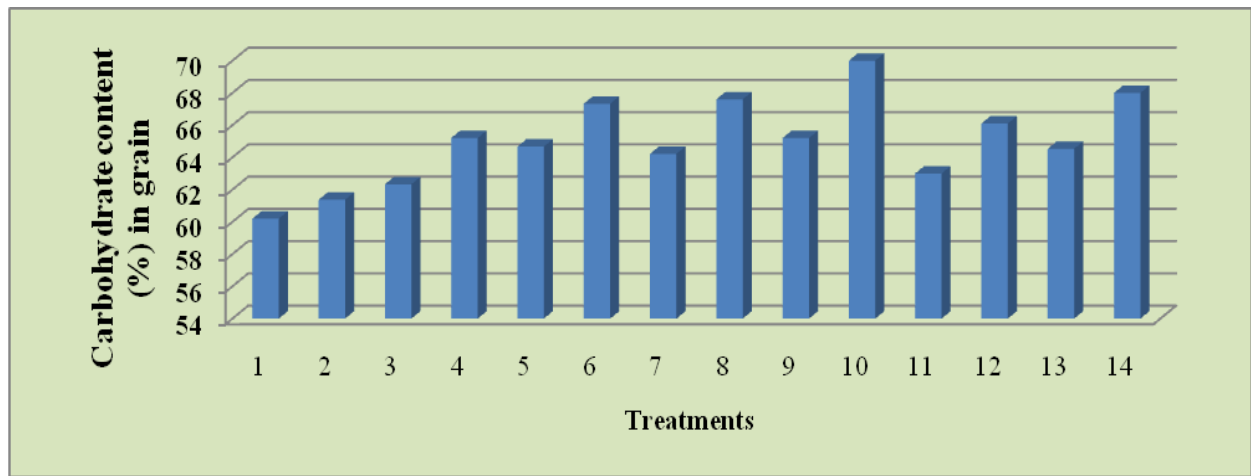


Fig.7 Effect of zinc and iron nutrition on Fe Content (ppm) in grain of finger millet

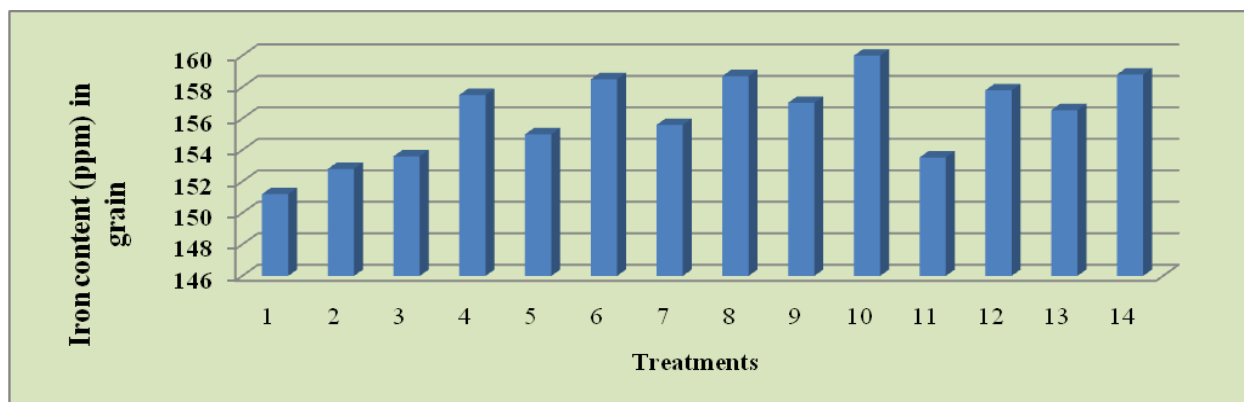
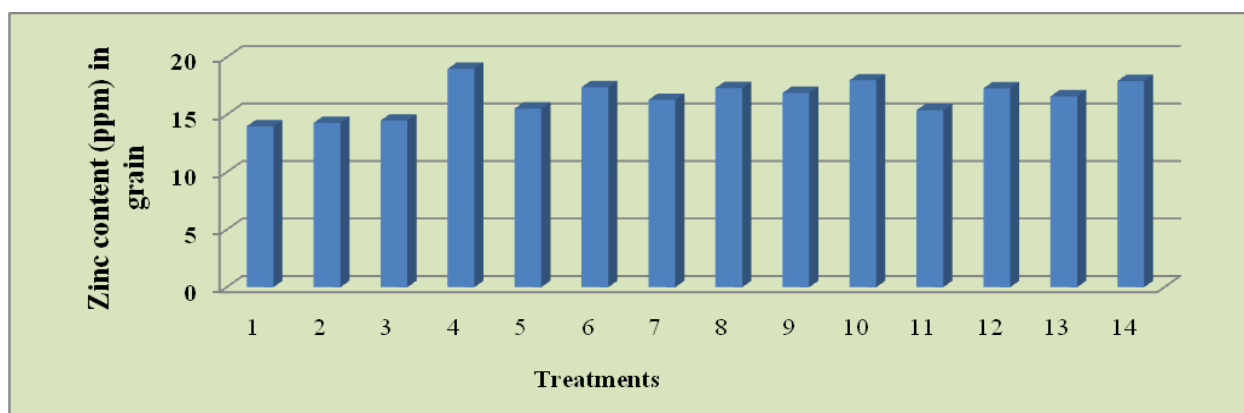


Fig.8 Effect of zinc and iron nutrition on Zn Content (ppm) in grain of finger millet



As a result, foliar application of zinc and iron develops plant growth, grain yield and enhances its quality. Under drought stress, foliar application of zinc and iron improved yield of wheat, grain filling stage being more responsive. (sultana *et al.*, 2018). Application of either Fe or Zn significantly increased N, P, Fe and Zn content in grain and straw of rice as compared to control (Patel *et al.*, 2017). (Table 2 and Figure 7).

Zinc (Zn) content in grain

There was no significant difference among the treatments. The zinc content in grain ranged between 14 ppm to 18 ppm in the treatments applied with RDF alone highest zinc content and RDF+ foliar application of ZnSO₄ @ 0.5% twice at 30 and 60 DAS. Ramegowda *et al.*, (2013) concluded that external application of Zn resulted in improved Zn concentration in different plant parts; in particular there was a significant increase in seed Zn concentration in all genotypes in finger

millet. Application of either Fe or Zn significantly increased N, P, Fe and Zn content in grain and straw of rice as compared to control (Patel *et al.*, 2017) (Table 2 and Figure 8).

Calcium content in grain

The calcium content in grain varied significantly among different treatments. The highest calcium content (2.33 %) in grain was noticed in treatment receiving RDF+ foliar application of FeSO₄ @ 0.5% twice at 30 and 60 DAS which was on par with treatment receiving RDF + foliar application of Fe-humate (2.0 %) twice at 30 and 60 DAS and lowest was recorded with application of RDF alone (1.10 %) (Table 2 and Figure 5).

Carbohydrate content in grain

There was no significant difference among the treatments. The carbohydrate content ranged from 60 to 70 % in plots applied with RDF+ foliar

application of FeSO₄ @ 0.5% twice at 30 and 60 DAS and RDF alone (Table 2 and Figure 6).

Protein content in grain

There was significant difference among the treatments and the highest protein content (11.25 %) in grain was noticed in treatment receiving RDF + foliar application of FeSO₄ @ 0.5% twice at 30 and 60 DAS which was on par with treatment receiving RDF + foliar application of Fe-humate and lowest was recorded with application of RDF alone (6.25 %). Foliar application of Zn and Fe increased grain yield and protein content in wheat (Seilsepour, 2007) (Table 2 and Figure 4).

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