Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
www.phytojournal.com
JPP 2020; 9(1): 1958-1960
Received: 13-11-2019
Accepted: 15-12-2019

Ajay Kumar E
M.sc(Ag), Department of Soil Science, PJTSAU Rajendranagar, Hyderabad, Telangana, India

Surekha K
Principal Scientist, Department of Soil Science, ICAR-Indian Institute of Rice Research, Hyderabad, Telangana, India

Bhanu Rekha K
Associate Professor, Department of Agronomy, College of Agriculture, Rajendranagar, Hyderabad, Telangana, India

Harish Kumar Sharma S
Professor, Department of Soil Science, College of Agriculture, Rajendranagar, Hyderabad, Telangana, India

Corresponding Author:
Ajay Kumar E
M.sc(Ag), Department of Soil Science, PJTSAU Rajendranagar, Hyderabad, Telangana, India

Impact of various sources of zinc and iron on soil nutrient status in finger millet (*Eleusine coracana* L.)

Ajay Kumar E, Surekha K, Bhanu Rekha K and Harish Kumar Sharma S

Abstract
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 soil nutrient status in finger millet. This experiment was conducted with 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 soil nutrient status in finger millet.The highest available N, P, K was obtained in treatment receiving RDF (60:40:30 kg N,P_2O_5 and K_2O kg ha^{-1}) + foliar application of $FeSO_4$ @ 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 at all the growth stages of finger millet.The highest available Fe was obtained in treatment receiving RDF+ $FeSO_4$ @ 50 kg ha^{-1} which was on par with RDF+ foliar application of $FeSO_4$ @ 0.5% twice at 30 and 60 DAS. The highest available Zn was obtained in treatment receiving RDF+ $ZnSO_4$ @ 50 kg ha^{-1} which was on par with treatment receiving RDF+ $ZnSO_4$ @ 0.2% foliar spray twice at 30 and 60 DAS.

Keywords: Finger millet, zinc, iron, available N, P, K, Fe and Zn

Introduction
Finger millet (*Eleusine coracana* L.) is an important small millet crop grown in India and has the pride of place characterized by highest productivity among millets. 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) [16]. 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 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) [5]. 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 defense factor in detoxification of highly toxic oxygen free radicals (Andreini *et al*., 2009) [1]. Iron deficiency is more severe in calcareous soils with low Fe availability due to high soil pH. Cropping systems of 200 to 300% intensity deplete the soil iron due to higher crop production. Thus, Fe deficiency is aggravated further as farmers do not apply it externally and its mining occurs. 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) [18].

Material and Methods
An 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}), P_2O_5(18.13 Kg ha^{-1})and high in K_2O(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 Table 1) and replicated thrice.

The gross plot size was 4.5 m × 4.5 m (20.25 m^2). Crop was sown by line sowing (variety GPU-28) 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, P_2O_5 and K_2O ha^{-1}. Entire recommended dose of phosphorous and potassium were applied as basal dose in the form of DAP and MOP. A uniform dose of nitrogen was applied through urea in 3 equal splits (1/3 rd as basal and 1/3 rd at vegetative phase and remaining 1/3rd) at panicle initiation stage to all the plots. Available nitrogen in the soil was determined by alkaline permanganate method as described by Subbaiah and Asija (1956) [15] and expressed as kg ha^{-1}. The available phosphorus was extracted from soil by Olsen's reagent as described by Olsen *et al*. (1954) [12]. The blue color was developed following ascorbic acid method (Watanabe and Olsen, 1965) and the intensity of blue color was measured at 660 nm by using Spectrophotometer (Elico SL– 177). The available phosphorus content was calculated and expressed as kg P_2O_5 ha^{-1}. Available potassium was extracted from soil using neutral normal ammonium acetate and was determined by using Flame photometer (Elico CL 361) as described by Jackson (1967) [9] and expressed as kg K_2O ha^{-1}. Available zinc and iron was extracted from soil using DTPA reagent and determined using Atomic Absorption Spectrophotometer (Lindsay and Norvell 1978) [11] and expressed in mg kg^{-1}.

Results and Discussion

Available N: There is steady decrease in available N from 30 DAS to harvest There was no significant difference between the treatments at 30 DAS and 60 DAS. Maximum available nitrogen at 30 and 60 DAS was recorded in the crop with (212 and 206 kg ha^{-1} respectively) in treatment receiving RDF+ foliar application of $FeSO_4$ @ 0.5% twice at 30 and 60 DAS. Maximum available nitrogen (202 kg ha^{-1}) at harvest was recorded in treatment receiving RDF+ foliar application of $FeSO_4$ @ 0.5% twice at 30 and 60 DAS which was on par with T_{14}, T_8, T_6, T_{12}, T_4, T_9, T_{13}, T_7. This may be attributed to supplementation of soil reservoir or mineralization of organic nitrogen from humic substances (Baskar, 2006 and Bhandari *et al*., 2000) [2, 3].

Available p: Maximum available phosphorus (61.6 kg ha^{-1}) at 30 DAS was recorded in treatment receiving RDF+ foliar application of $FeSO_4$ @ 0.5% twice at 30 and 60 DAS which was on par with T_{14}, T_8, T_6, T_{12}, T_4, T_9, T_{13}, T_7, T_5, T_3, T_{11}. Maximum available phosphorus (52.8 kg ha^{-1}) at 60 DAS was recorded in treatment receiving RDF+ foliar application of $FeSO_4$ @ 0.5% twice at 30 and 60 DAS which was on par with T_{14} treatment. maximum available phosphorus at harvest was recorded in (36.7 kg ha^{-1}) in treatment receiving RDF+ foliar application of $FeSO_4$ @ 0.5% twice at 30 and 60 DAS and lowest was recorded with application of RDF alone. The humic acid and fulvic acid might have helped in solubilizing P from insoluble to soluble form resulting its increase. The phosphate ions interact with humic acid and fulvic acid more through its phenolic and hydroxyl group which might have changed the behaviour of "P" (Bharath and Madhavi 2015) [4] in sorghum and similar increase was also reported by Khan *et al*. (1997) [10]. The increase in P availability might also be due to the mineralization of soil organic P (Dusberg *et al*., 1989) as well as by humic acid (Vaughan and Ord, 1985) [17].

Available K: Maximum available potassium (495 and 490 kg ha^{-1}) at 30 and 60 DAS was recorded in treatment receiving RDF+ foliar application of $FeSO_4$ @ 0.5% twice at 30 and 60 DAS which was on par with T_{14}, T_8 treatments. Maximum available potassium (484 kg ha^{-1}) at harvest was recorded in treatment receiving RDF+ foliar application of $FeSO_4$ @ 0.5% twice at 30 and 60 DAS which was on par with T_{14} treatment. The humic acid and fulvic acid are believed to play a definite role in liberating fixed K because of their chelating power. In addition, the lower molecular weight of humic fractions of humic compounds is capable of penetrating the intermicellar spaces of expanding types of clays and reaches the specific sorption sites for K, where they might react or compete for sites with K and increases its availability in soil observed by Bharath and Madhavi (2015) in sorghum ; Schnitzer and Kodama, (1972) and Raina and Goswami (1988) in maize plant. It was also reported that at pH 7.0, humic and fulvic acids were capable of dissolving small amounts of K from the minerals by chelating action, complex reactions or both.

Available Fe: Maximum available iron (10 ppm) at 30 DAS was recorded in treatment receiving RDF+ $FeSO_4$ @ 50 kg ha^{-1} which was on par with T_{10} treatment. There was no significant difference between the treatments at 60 DAS and at harvest. Maximum available iron at 60 DAS and at harvest was recorded in the crop with (5.98 and 3.92 ppm) treatment receiving RDF+ $FeSO_4$ @ 50 kg ha^{-1} and lowest was recorded with application of RDF alone. Maxium available iron in soil in treatment receiving RDF+ $FeSO_4$ @ 50 kg ha^{-1}.Similar results was also obtained by Patil *et al*., 2018 in pearl millet and Ghritlahare *et al*., 2015 in okra.

Available Zn: Maximum available zinc at 30 DAS was recorded with (3.2 ppm) treatment receiving RDF+ $ZnSO_4$ @ 50 kg ha^{-1} which was on par with T_4, T_9 treatments. Maximum available zinc at 60 DAS and at harvest was recorded with (2.9 and 1.6 ppm) treatment receiving RDF+ $ZnSO_4$ @ 50 kg ha^{-1}which was on par with T_4, T_9, T_{10} treatments. Patil *et al*., (2018) reported maximum available Fe (5.92 mg kg^{-1}) and Mn (9.34 mg kg^{-1}) was noticed in pear millet under gross recommended dose of fertilizer + soil application of 25 kg ha^{-1} $FeSO_4$, while, the maximum availability of Zn and Cu (0.62 and 1.10 mg kg^{-1}, respectively) was observed with gross recommended dose of fertilizer + soil application of 20 kg ha^{-1} $ZnSO_4$.

Table 1: Effect of Zinc and Iron nutrition on available Nitrogen, Phosphorus and Potassium at different stages of finger millet (kg ha^{-1}).

Treatment	Nitrogen (kg ha^{-1})			Phosphorus (kg ha^{-1})			Potassium (kg ha^{-1})		
	30 DAS	60 DAS	Harvest	30 DAS	60 DAS	Harvest	30 DAS	60 DAS	Harvest
T_1	197	180	151	40.4	33.3	26.3	452	440	432
T_2	197	183	166	51.4	34.5	26.6	454	442	435
T_3	198	186	178	52.6	35.9	26.9	458	446	440
T_4	206	191	185	57.5	44.1	31.2	476	468	464
T_5	202	186	180	54.6	39.3	27.7	460	452	446
T_6	208	193	186	59.5	48.0	32.9	482	478	472

T_7	204	189	182	56.3	39.8	28.6	462	457	450
T_8	210	198	194	60.7	48.9	34.1	486	482	476
T_9	205	190	184	57.2	42.4	30.3	472	463	460
T_{10}	212	206	202	61.6	52.8	36.7	495	490	484
T_{11}	199	185	178	52.6	36.2	27.1	458	450	444
T_{12}	206	193	188	57.8	44.9	32.1	478	472	467
T_{13}	205	189	185	56.9	41.2	29.5	468	460	456
T_{14}	210	197	199	60.9	51.1	34.4	490	486	480
Initial	132 (kg ha^{-1})			18.13 (kg ha^{-1})			464.8 (kg ha^{-1})		
S. E m. ±	18.75	7.3	7.06	3.170	0.541	0.281	3.68	2.8	1.68
C.D. (0.05)	NS	NS	20.65	9.26	1.58	0.821	10.77	8.2	4.92

Table 2: Effect of Zinc and Iron nutrition on available zinc and iron at different stages of finger millet (ppm).

Treatment	Zinc content (ppm)			Iron content (ppm)		
	30 DAS	**60 DAS**	**Harvest**	**30 DAS**	**60 DAS**	**Harvest**
T_1- RDF (60-40-30 Kg N-P_2O_5-K_2O ha^{-1})	1.4	1.1	0.3	4.8	5.62	3.48
T_2 - Vermicompost + RDF	1.6	1.3	0.4	5.0	5.68	3.50
T_3-RDF+$ZnSO_4$@50kgha^{-1}soil application.(Basal)	3.2	2.9	1.6	7.5	5.9	3.84
T_4 - RDF + $ZnSO_4$ @ 0.2% foliar spray twice at 30 and 60 DAS	2.8	2.8	1.5	7.4	5.88	3.80
T_5 - RDF + Zn-EDTA soil application	2.2	1.9	0.9	5.3	5.64	3.56
T_6 - RDF + Zn-EDTA foliar spray twice at 30 and 60 DAS.	2	1.7	0.8	5.0	5.66	3.52
T_7 - RDF + Zn Humate soil application.	2.5	2.4	1.2	6.6	5.77	3.70
T_8 - RDF + Zn Humate foliar spray @ 0.25% twice at 30 and 60 DAS.	2.6	2.5	1.3	6.4	5.74	3.65
T_9 - RDF + $FeSO_4$ @ 50kg ha^{-1} soil application.	2.8	2.6	1.4	10	5.98	3.92
T_{10} - RDF + $FeSO_4$ @ 0.5% foliar spray twice at 30 and 60 DAS.	2.7	2.6	1.4	8.4	5.94	3.88
T_{11} - RDF + Fe-EDTA soil application.	1.9	1.5	0.7	6.0	5.7	3.62
T_{12} - RDF + Fe-EDTA foliar spray twice at 30 and 60 DAS	1.8	1.4	0.6	5.7	5.68	3.60
T_{13} - RDF + Fe Humate soil application	2.5	2.3	1.1	7.0	5.82	3.77
T_{14}-RDF + Fe Humate foliar spray twice at 30 and 60 DAS	2.3	2	1.0	6.88	5.8	3.75
Initial	0.3 (ppm)			3.8 (ppm)		
S. E m. ±	0.1	0.14	0.09	0.37	0.27	0.27
C.D. (0.05)	0.31`	0.43	0.27	1.08	NS	NS

References

1. Andreini BI, Rosato A, Metalloproteomes. A bioinformatic approach, Accounts of Chemical Research. 2009; 42:1471-1479.
2. Baskar K. Growth, yield and N uptake of Turmeric (*Curcuma longa* L.) in alfisols as affected by lignite humic acid. Madras Agricultural Journal. 2006; 93(713):282-28.
3. Bhandari AL, Walia SS, Singh T. Effect of mineralization of organic N in FYM. New Agriculturist. 2000, 231.
4. Bharath T, Madhavi K. Nutrient uptake of Sorghum crop influenced by top dressing and foliar application of organic nutrient sources. Indian Journal of Applied Research. 2015; 5(4):19-22.
5. Chaturvedi R, Srivastava S. Genotype variations in physical, nutritional and sensory quality of popped grains of amber and dark genotype of finger millet. Journal of Food Science Technology. 2008; 45(5):443-446.
6. Dusberg JM, Smith MS, Doran JW. Dynamics of SOM in tropical ecosystems. University of Hawaii, USA, 1989.
7. Fulpagare DD, Patil TD, Thakare RS. Effect of application of iron and zinc on nutrient availability and pearl millet yield in vertisols. International Journal of Chemical Studies. 2018; 6(6):2647-2650.
8. Ghritlahare A, Marsonia P, Sakarvadia HL. Effect of zinc and iron on yield and yield attributes of okra (*Abelmoschus esculentus* L.). Asian Journal of Soil Science. 2015; 10(1):104-107.
9. Jackson, M.L. Soil Chemical Analysis. Prentis Hall of India Pvt. Ltd., New Delhi, 1967.
10. Khan S, Qureshi MA, Singh J, Praveen G. Influence of Ni (ii), Cr (ii) and humic acid (HA) complexes on major nutrients (NPK) status of soil. Indian Journal of Agricultural Chemistry. 1997; 31:1-5.
11. Lindsay WL, Norvell WA. Development of DTPA soil test for zinc, iron, manganese and copper. Soil Science Society of America Journal. 1978; 43:421-428.
12. Olsen SR, Cole CV, Watanabe FS, Dean LA. Estimation of available phosphorus in soils by extraction with sodium bicarbonate, Circular U.S. Department of Agriculture, 1954, 939.
13. Raina JN, Goswami KP. Effect of fulvic acid and fulvates on growth and nutrient uptake by maize plant. Journal of the Indian Society of Soil Science. 1988; 36:264-268.
14. Schnitzer M, Kodama H. Differential thermal analysis of metal fulvic acid salts and complexes. Geoderma. 1972; 7:93-103.
15. Subbaiah BV, Asija GL. A rapid procedure for the determination of available nitrogen in soils. Current Science. 1956; 25:259-260.
16. Thippeswamy TG, Junna L, Shinde M. proximate composition, resistant starch and other phytochemical constituents of native finger millet cultivar. International journal of food and nutritional science. 2016; 3(5):2320-7876.
17. Vaughan D, Ord BG. Soil organic matter a perspective on its nature, extraction, turn over and role in soil fertility. Soil organic matter and biological activity. 4-18. Junk publishers, Water land, 1985.
18. Vikash K, Dinesh K, Singh YV, Rishi R. Effect of Iron fertilization on drymatter production, yield and economics of aerobic rice (*Oryza sativa* L.). Indian Journal of Agronomy. 2015; 60(4):547-553.