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Influence by Various Zinc and Iron Treatments on Micronutrients Content and Uptake of Grain and Stover of Pearl Millet

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A B S T R A C T

The filed study was "Influence by various treatments of micronutrient of content and uptake grain and stover of pearl millet crop" was carried out during *kharif* season of the year 2016, at College Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand. Fe and Zn content in grain of pearl millet was improved due to application of Zn and Fe treatments. Application of 25 kg $ZnSO_4$ ha^{-1} + 1.0 kg Fe ha^{-1} (T_8) increased 20.2 and 19.6 percent Fe and Zn content of grain respectively over control. To Significantly higher grain uptake of Fe (118.32 g ha^{-1}) was found with application of 1.5 kg Zn ha^{-1} + 50 kg $FeSO_4$ (T_5) ha^{-1} as compared to control (T_1), but it was par with the rest of treatments. Application of 25 kg $ZnSO_4$ ha^{-1} + 1.0 kg Fe ha^{-1} (T_8) gave higher uptake of Zn (64.98 g ha^{-1}) as compare to 0 kg Zn ha^{-1} + 50 kg $FeSO_4$ ha^{-1} (T_2) and control (T_1), while rest treatments were at par with T_8.Improvement in Zn and Fe content of straw was observed due to application of Zn and Fe. Significantly higher content of Fe (70.75 mg kg^{-1}) was found with treatment 25 kg $ZnSO_4$ ha^{-1} + 50 kg $FeSO_4$ ha^{-1} (T_{10}), which was at par with all treatments barring control. Treatments 25 kg $ZnSO_4$ ha^{-1} + 0 kg Fe ha^{-1} (T_6), 25 kg $ZnSO_4$ ha^{-1} + 0.5 kg Fe ha^{-1} (T_7) and 25 kg $ZnSO_4$ ha^{-1} + 1.5 kg Fe ha^{-1} (T_{10}), produced higher content of Zn over the control. Treatments of zinc and iron had significant effect on iron and zinc uptake of straw. Application of 25 kg $ZnSO_4$ ha^{-1} + 50 kg $FeSO_4$ ha^{-1} (T_{10}) recorded higher removal of Fe (463.83 g ha^{-1}) and Zn (47.87 g ha^{-1}) over control (T_1).

Introduction

Pearl millet (*Pennisetum glaucum* (L.) is one of the important food grain crop of India ranking fourth in average to rice, wheat and sorghum in that order. Its common name over a large part of India is *bajra* or *bajri*. Pearl millet cultivation is mainly confined to the arid and semi - arid zones prehistoric time. Gujarat ranks third in the production of pearl millet in India whereas Rajasthan tops the list and Uttar Pradesh is in second position. It is cultivated over an area of 0.39 million hectares in Gujarat. The total production is 0.79 million tones and the productivity is 2004 kg ha^{-1}(Anon., 2016). The nutritive value of pearl millet is fairly high. It contains 5 per cent fat (either extract), 9.15 per cent protein, 2.7 per cent mineral matter and gives 360 calories per 100g with high amount of vitamins A and B, it imparts substantial energy to the body with easy digestibility. In addition on grain, it also supplies fair quality dry fodder in large bulk (Parmar *et al*., 2020).

The nutritive value of pearl millet crop is fairly high. It contains 12.4% moisture, 11.6 % protein, 5 % fat, 67% carbohydrates and about 2.7 % minerals. It is also rich in Vit-A, Vit-B and impart substantial energy for baby (360 calories $100g^{-1}$) (Malik, 2015). Pearl millet grains are eaten cooked like rice or "chapatis" are prepared out of flour like maize or sorghum flour. Agricultural produces, lower in micronutrient content, failed to meet up its (Zn) requirements for human nutrition (Kharadi *et al.*, 2020). Continuous reliance on high proportion of cereals-based foods with low amount and availability of Zn appears to be the major reason for the widespread occurrence of the Zn deficiency problem in human.

Iron (Fe) plays an important role in the plant growth. It is a cofactor for approximately 140 enzymes that catalyze unique biochemical reactions. Deficiency or low activity of iron in the plant causes chlorophyll is not produced in sufficient quantities and the leaves are pale. It helps in the formation of chlorophyll and is constituent of enzyme systems which bring about oxidation reductions in plants. Fe is essential for respiration, photosynthesis and fixation of atmospheric nitrogen by nitrogen fixing organisms. Scenario of micronutrient deficiency in north India in early eighties was different than now after four decades. Zinc deficiency remained a major problem all over country. Zinc deficiency has increased from44 % to 48% and expected to further increase up to 63 % by 2025 as most of the marginal soil are showing higher response to added zinc (Parmar *et al*., 2020).

Materials and Methods

The filed study was planned to during *kharif* season of the year 2016 at the College Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand. The experimental plot was prepared as per the method described by Bhuriya *et al* (2019). The soil of the experimental field was alkaline in reaction and soluble salt content under safe limit. It was low in organic carbon, available N, low in available nitrogen, high in available phosphorus and available potash, while medium in available zinc and iron.Analysis dried samples (leaf and grain) were digested in di-acid mixture ($4HNO_3$**:**$1HClO_4$) and volume was made up with double distilled water (Jackson, 1973). The extract was filtered through Whatman filter paper No. 42. The digested extract of plant samples was used for analysis of N, P, K, Micronutrients content and uptake was analyzed by Kjeldahl digestion method.

Total 10 treatments were included in the present investigation treatments were comprised of Zn and Fe fertilizers application through $ZnSO_4$ and $FeSO_4$ as well as chelated forms of Zn and Fe.$T_1$0 kg Zn ha^{-1} + 0 kg Fe ha^{-1}(control), T_2 0 kg Zn ha^{-1}+ 50 kg $FeSO_4$ ha^{-1},$T_3$0.5 kg Chelated Zn ha^{-1}+ 50 kg $FeSO_4$ ha^{-1},$T_4$1.0 kg Chelated Zn ha^{-1} + 50 kg $FeSO_4$ ha^{-1},$T_5$1.5 kg Chelated Zn ha^{-1} +50 kg $FeSO_4$ ha^{-1},$T_6$25 kg $ZnSO_4$ ha^{-1} + 0 kg Fe ha^{-1},$T_7$25 kg $ZnSO_4$ ha^{-1} + 0.5 kg Chelated Fe ha^{-}1,T825 kg $ZnSO_4$ ha^{-1}+1.0 kg Chelated Fe ha^{-1},$T_9$25 kg $ZnSO_4$ ha^{-1}+1.5 kg Chelated Feha^{-1},T_{10} 25 kg $ZnSO_4$ ha^{-1}+ 50 kg $FeSO_4$ ha^{-1}.

Zn_0, $Zn_{0.5}$, $Zn_{1.0}$ and $Zn_{1.5}$:0.0, 0.5, 1.0 and 1.5 kg Zn Chelated

Fe_0, $Fe_{0.5}$, $Fe_{1.0}$ and $Fe_{1.5}$:0.0, 0.5, 1.0 and 1.5 kg Fe Chelated

Zn_{25}: $ZnSO_4$25 kgha^{-1}
Fe_{50}: $FeSO_4$50 kgha^{-1}

Results and Discussion

Effect of nutrient content and uptake on grain of pear millet

Among iron, manganese, zinc and copper content in grain, only iron and zinc content were significantly altered where in increasing trend observed with application of Zn and Fe (Table 1). Application of $ZnSO_4$@25kg + chelated Fe@1.0kg Fe ha^{-1} (T_8) and 1.5 kg Zn ha^{-1} + 50kg $FeSO_4$ ha^{-1} (T_5) showed significantly higher Fe content (39.38 mg^{-1}) as compare to control (32.75 mg^{-1}) but, it was at par with other treatments. The percent increase in Fe content was 20.24% due to T_8 and T_5 over T_1.

Significantly improvement in Zn content in grain of pearl millet due to application of Zn and Fe treatments was recorded. Treatment 25 kg $ZnSO_4$ ha^{-1} + 1.0 kg Fe ha^{-1} (T_8), increased 19.6% Zn content as compare to no application of Zn and Fe (T_1). The Zn content was significantly the lowest, under no application of application of Zn and Fe, but it remained at par with application of 0 kg Zn ha^{-1} + 50 kg $FeSO_4$ ha^{-1}(T_2). Generally, all the treatments gave better performance in increasing Zn and Fe contents over the control. Increases in grain Fe and Zn concentration in cereal with an increase in Fe and Zn additions has been reported by several workers (Dhaliwal *et al.*, 2009; Yilmaz *et al.*, 1997; Seilsepour, 2006; Pahlavan Rad and Pessarakli, 2009; Cakmak *et al.*, 2010; in wheat and Mukhi and Shukla, 1987 and Dhaliwal *et al.*, 2010 in rice).

The significant effect of zinc and iron application was observed for Fe and Zn uptake, while non-significant effect showed for Mn and Cu uptake by grain (Table 1). Significantly higher uptake of Fe (118.32 g ha^{-1}) was found with application of1.5 kg chelated Zn ha^{-1} + 50 kg $FeSO_4$ (T_5) ha^{-1} as compared to control (T_1), but it was at par with the rest of treatments. Zn uptake by pearl millet was also increased with the application Zn and Fe treatments (Table 1).

Table.1 Iron, manganese, zinc and copper content and uptake by grain as influenced by different treatments of zinc and iron on pear millet

Treatments		Nutrient content in grain (mg kg^{-1})				Nutrient uptake in grain (%)			
		Fe	Mn	Zn	Cu	Fe	Mn	Zn	Cu
T_1	Zn_0Fe_0	32.75	8.88	18.50	2.25	85.15	22.77	47.80	5.82
T_2	Zn_0Fe_{50}	37.63	8.95	20.00	2.38	104.77	24.92	55.58	6.64
T_3	$Zn_{0.5}Fe_{50}$	38.50	9.00	20.63	2.38	109.95	25.70	59.02	6.78
T_4	$Zn_{1.0}Fe_{50}$	38.88	9.13	21.00	1.88	114.46	26.90	61.97	5.53
T_5	$Zn_{1.5}Fe_{50}$	39.38	9.06	21.63	2.13	118.32	27.08	64.83	6.43
T_6	$Zn_{25}Fe_0$	37.38	9.13	21.00	2.25	105.72	25.78	59.40	6.34
T_7	$Zn_{25}Fe_{0.5}$	38.88	9.00	21.38	2.38	113.42	26.22	62.44	6.91
T_8	$Zn_{25}Fe_{1.0}$	39.38	9.06	22.13	2.25	115.67	26.63	64.98	6.61
T_9	$Zn_{25}Fe_{1.5}$	39.25	9.13	21.00	2.38	113.83	26.38	60.92	6.90
T_{10}	$Zn_{25}Fe_{50}$	38.25	9.19	20.75	2.25	118.00	28.32	64.02	6.95
SEm±		1.13	0.39	0.65	0.17	4.89	1.10	2.60	0.56
CD at 5%		3.29	NS	1.88	NS	14.18	NS	7.56	NS
CV %		5.96	8.67	6.24	14.75	8.89	8.40	8.66	17.12

Table.2 Iron, manganese, zinc and copper content and uptake by stover as influenced by different treatments of zinc and iron on pearl millet

Treatments		Nutrient content in stover ($mg kg^{-1}$)				Nutrient uptake by stover ($g\ ha^{-1}$)			
		Fe	Mn	Zn	Cu	Fe	Mn	Zn	Cu
T_1	Zn_0Fe_0	63.50	12.00	6.50	2.56	331.51	62.59	33.92	13.37
T_2	Zn_0Fe_{50}	69.88	13.00	7.13	2.50	407.66	75.85	41.61	14.59
T_3	$Zn_{0.5}Fe_{50}$	69.63	14.00	7.25	2.88	415.91	83.43	43.47	17.27
T_4	$Zn_{1.0}Fe_{50}$	69.13	13.00	7.38	2.50	420.20	78.73	44.86	15.12
T_5	$Zn_{1.5}Fe_{50}$	69.25	12.25	7.25	2.50	428.23	75.77	44.97	15.51
T_6	$Zn_{25}Fe_0$	67.63	13.63	7.75	2.25	401.37	80.92	46.04	13.36
T_7	$Zn_{25}Fe_{0.5}$	69.00	13.00	7.75	2.50	414.42	77.91	46.57	14.99
T_8	$Zn_{25}Fe_{1.0}$	68.50	12.38	7.50	2.88	415.25	74.06	45.60	17.19
T_9	$Zn_{25}Fe_{1.5}$	70.40	12.50	7.50	2.88	426.44	75.76	45.41	17.40
T_{10}	$Zn_{25}Fe_{50}$	70.75	12.38	7.75	2.56	436.83	77.21	47.87	15.89
SEm±		1.33	0.99	0.24	0.19	12.98	5.91	2.20	1.19
CD at 5%		3.86	NS	0.70	NS	37.66	NS	6.39	NS
CV %		3.87	15.39	6.50	14.82	6.33	15.52	10.01	15.39

The Zn uptake ranged between 47.80 to64.98 g ha^{-1}.Application of 25 kg $ZnSO_4$ ha^{-1} + 1.0 kg chelated Fe ha^{-1} (T_8) gave higher uptake of Zn (64.98 g ha^{-1}) as compare to 0 kg Zn ha^{-1} + 50 kg $FeSO_4$ ha^{-1} (T_2) and control (T_1) while rest of the treatments were at par with T_8. Regarding Mn and Cu uptake, though results were non-significant, slightly improvement observed with application Zn and Fe levels may be due to increase in pearl millet yield under different treatments Increased in Fe and Zn uptake by grain of pearl millet due to soil application of 25kg $ZnSO_4$ ha^{-1} and 50kg $FeSO_4$ ha^{-1} was also reported by Jain *et al.*, (2018).

Effect of nutrient content and uptake on stover of pearl millet

The significant variable effect of Fe and Zn application was observed for Fe and Zn contents of stover, but not for Mn and Cu content. Significantly higher content of Fe (70.75 mg kg^{-1}) was recorded with treatment 25 kg $ZnSO_4$ ha^{-1} + 50 kg $FeSO_4$ ha^{-1} (T_{10}), which was at par with all treatment barring (T_1) control in (Table 2). Regarding Zn content, improvement was observed due to application of Zn and Fe. It was found in ranges from 6.50 to 7.75 mg kg^{-1} in different treatments. Significantly higher content of Zn found under application of 25 kg $ZnSO_4$ ha^{-1} + 0 kg Fe ha^{-1}(T_6), 25 kg $ZnSO_4$ ha^{-1} + 0.5 kg Fe ha^{-1} (T_7) and 25 kg $ZnSO_4$ ha^{-1} + 1.5 kg Fe ha^{-1} (T_{10}) over (T_1) control. Treatments T_6, T_7 and T_{10}resulted in 19.20 per cent increased Zn content over control. These findings are in line with those reported Patel *et al.*, (2008) and Yadav *et al.*, (2011).Similarly increased zinc concentration in straw with the zinc application in soil with below 0.60 mg kg^{-1} DTPA-Zn also reported by Dwivedi and Tiwari (1992). Soil application of 25kg $ZnSO_4$ ha^{-1} and 50kg $FeSO_4$ ha^{-1} significantly improved Fe and Zn uptake in straw of pearl millet (Jain *et al.*, 2018).

The data revealed that only uptake of iron and zinc was significantly increased due to Zn and Fe treatments. Application of 25kg $ZnSO_4$

ha^{-1}+ 50kg $FeSO_4$ ha^{-1}(T_{10}) recorded higher removal of Fe (436.83 g ha^{-1}) and Zn (47.87 g ha^{-1}) over control (T_1) and is being par with other treatments in (Table 2). The removal of Fe was in range of 331.51 to 436.83 and 33.92 to 47.87 g ha^{-1} for Zn due to different treatments. Arya and Singh (2000) noticed that application of 25kg $ZnSO_4$ ha^{-1} significantly increased zinc uptake instraw of maize. Soil application of 25kg $ZnSO_4$ ha^{-1} and 50kg $FeSO_4ha^{-1}$ significantly improved Feand Zn uptake by straw of pearl millet (Jain *et al.,* 2018).No significant differences on uptake of Mn and Cu observed however, improvement in uptake was found with application of iron and zinc treatments over control (T_1) in Table 2, may be due to increase in pearl millet yield due to different treatments.

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