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Identification and enrichment of pearlmillet [*Pennisetum glaucum* (L.)] genotypes with zinc and iron through agronomic biofortification

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Abstract
A field experiment was conducted at Agricultural College Farm, Raichur, Karnataka, during *kharif* 2016-2017 to studies on identification and enrichment of pearlmillet [*Pennisetum glaucum* (L.)] genotypes with zinc and iron through agronomic biofortification, nitrogen content in grain, stover and total nitrogen content of pearlmillet genotypes, G_3: HFeZn-113(high in Zn & Fe) (2.41, 1.33 and 3.74%, respectively). Among micronutrient applications M_7: Soil application of $ZnSO_4$ @ 15 kg ha^{-1} & $FeSO_4$ @ 10 kg ha^{-1} + Foliar application of 0.5% $ZnSO_4$ and $FeSO_4$ each (2.71, 1.58 and 4.29%, respectively). Phosphorus content in grain, stover and total phosphorus content of pearlmillet genotypes recorded with G_3: HFeZn-113 (high in Zn & Fe) (1.22, 0.15 and 1.37%, respectively). Among micronutrient applications M_7: Soil application of $ZnSO_4$ @ 15 kg ha^{-1} & $FeSO_4$ @ 10 kg ha^{-1} + Foliar application of 0.5% $ZnSO_4$ and $FeSO_4$ each (2.21, 0.17 and 2.12%, respectively). Potassium content in grain, stover and total potassium content of pearlmillet genotypes, G_3: HFeZn-113 (high in Zn & Fe) (0.89, 1.83 and 2.72%, respectively). Among micronutrient applications M_7: Soil application of $ZnSO_4$ @ 15 kg ha^{-1} & $FeSO_4$ @ 10 kg ha^{-1} + Foliar application of 0.5% $ZnSO_4$ and $FeSO_4$ each (1.01, 1.99 and 3.01% , respectively). The concentration of zinc in grain, stover and total zinc concentration of pearlmillet genotypes G_3: HFeZn-113 (high in Zn & Fe) (29.56, 38.89 and 66.45 ppm, respectively). Among micronutrients application, significantly higher zinc concentration in M_7: Soil application of $ZnSO_4$ @ 15 kg ha^{-1} & $FeSO_4$ @ 10 kg ha^{-1} + Foliar application of 0.5% $ZnSO_4$ and $FeSO_4$ each (33.50, 45.39 and 78.72 ppm, respectively). The concentration of iron in grain, stover and total iron concentration of pearlmillet genotypes, G_3: HFeZn-113 (high in Zn & Fe) (177.18, 166.71 and 342.26 ppm, respectively). Among micronutrients application, significantly higher iron concentration in M_7: Soil application of $ZnSO_4$ @ 15 kg ha^{-1} & $FeSO_4$ @ 10 kg ha^{-1} + Foliar application of 0.5% $ZnSO_4$ and $FeSO_4$ each (195.45, 182.18 and 377.68 ppm, respectively).

Keywords: Pearlmillet, nutrient content, nutrient concentration, nutrient availability in soil

Introduction
Pearlmillet [*Pennisetum glaucum* (L.)] is the fifth most important cereal crop and widely grown in India during *kharif*. It is cultivated by economically poor farmers and provides staple food for the poor in short period in the relatively dry tracts of semi arid India. Now a days, in the context of changing climate, this crop is mostly identified as contingent crop in the country particularly in dry areas. Pearlmillet grain is the staple diet and nutritious source of vitamins, minerals, protein and carbohydrates, while its stover is a valuable livestock feed. In India, it is cultivated on an area of 7.30 m ha with the production of 8.73 m t, among which only 8.5 per cent cultivated area is under irrigation. Karnataka state stands 5^{th} position in area (0.28 m ha) and production (0.29 m t) with the productivity of 1036 kg ha^{-1} (Anon, 2014). The major area is confined to dry regions of northern Karnataka and generally grown as a rainfed crop and fits well in various cropping systems

Zinc and iron deficiencies are well-documented public health issue an important soil constraint to crop production. Generally, there is a close geographical overlap between soil deficiency and human deficiency of Zn and Fe, indicating a high requirement for increasing concentrations of these nutrients in food crops. It general has 9 to13 per cent protein but large variation among genotype ranging from 6 to 21 per cent has been observed. Pearlmillet contains more calories than wheat, probably because of its higher oil content of 5 per cent of which 50 per cent are poly unsaturated fatty acid. It is rich in calcium, potassium, magnesium, iron, zinc, manganese, riboflavin, thiamine, niacin, lysine and tryptophan.

Agronomic biofortification providing Zn and Fe to plants by seed treatment and applying Zn or Fe fertilizers to soil and foliar appears to be important to ensure success of breeding efforts for increasing Zn and Fe concentration in grain. Fertilizer strategy could be a rapid solution to the problem and can be considered an important complementary approach to the on-going breeding programs. Fertilizer studies focusing specifically on increasing Zn and Fe concentration of grain are, however, very rare. The most effective method for increasing Zn and Fe in grain will be the combined application through soil and foliar method which results in an increase concentration of Zn and Fe in grain in addition to seed treatment. In most parts of the cereal growing areas, soils have, however, a variety of chemical and physical problems that significantly reduce availability of Zn and Fe to plant roots. Hence, the genetic capacity of the newly developed (biofortified) cultivars to absorb sufficient amount of Zn and Fe from soil and accumulate it in the grain may not be expressed to the full extent. It is, therefore, essential to have a short-term approach to improve Zn and Fe concentration in grains.

Material and methods

The field experiment was conducted at Agricultural College Farm, Raichur, which is situated between 16º 12' N latitude and 77º 20' E longitude with an altitude of 389 meters above the mean sea level and is located in zone II of Karnataka. The experiment was laid out in split plot design and comprised of two factors for study *viz.*, Main plot treatments: genotypes (G) comprised *viz.*, G_1: HFeZn-102 (low in Zn & Fe), G_2: IP-17720 (medium in Zn & Fe) and G_3: HFeZn-113 (high in Zn & Fe). Subplots treatments: micronutrients application (M) comprised *viz.*, M_1: Control, M_2: Seed treatment with 1% $ZnSO_4$ & $FeSO_4$ each, M_3: Soil application of $ZnSO_4$ @ 15 kg ha^{-1} and $FeSO_4$ @ 10 kg ha^{-1}, M_4: Foliar application of 0.5% $ZnSO_4$ and $FeSO_4$ each at 30 and 45 DAS, M_5: Seed treatment + Soil application (M_2 + M_3), M_6: Seed treatment + Foliar application (M_2 + M_4) and M_7: Soil application + Foliar application (M_3 + M_4). Treatments M_1 to M_7 includes, RDF: 50:25:00 kg N, P_2O_5 and K_2O ha^{-1} + FYM @ 2.5 t ha^{-1}). The soils of the experimental site belong to medium deep black soil and clay texture, neutral in soil reaction (8.15) and low in electrical conductivity (0.46 dSm^{-1}). The organic carbon content was 0.69 per cent and low in available N (192.00 kg ha^{-1}), medium in available phosphorus (22.90 kg P_2O_5 ha^{-1}) and high in available potassium (251.00 kg K_2O ha^{-1}). DTPA extractable zinc (0.55 ppm) and DTPA extractable iron (3.72 ppm). The mean monthly meteorological data of rainfall, temperature and relative humidity during the period of experimentation (2016-17) recorded at the meteorological observatory of the MARS, Raichur**.**

Results and discussion

In the present study, total nitrogen content of pearlmillet genotypes, G_3: HFeZn-113(high in Zn & Fe) (3.74%). However, which was found on par with G_2: IP-17720 (medium in Zn & Fe) (3.50%) as compared to G_1: HFeZn-102 (low in Zn & Fe). Among various micronutrient applications M_7: Soil application of $ZnSO_4$ @ 15 kg ha^{-1} & $FeSO_4$ @ 10 kg ha^{-1} + Foliar application of 0.5% $ZnSO_4$ and $FeSO_4$ each recorded significantly higher total nitrogen content (4.29%) compared to the other treatments, *viz*., Control (2.64%).Total phosphorus content of pearlmillet genotypes was recorded with G_3: HFeZn-113 (high in Zn & Fe) (1.37%). However, which was found on par with G_2: IP-17720 (medium in Zn & Fe) (1.15%). Among micronutrient applications M_7: Soil application of $ZnSO_4$ @ 15 kg ha^{-1} & $FeSO_4$ @ 10 kg ha^{-1}+ Foliar application of 0.5% $ZnSO_4$ and $FeSO_4$ each recorded significantly higher total phosphorus content (2.12%) as compared to the other treatments, *viz*., Control (0.68%). Similarly total potassium content of pearlmillet genotypes, G_3: HFeZn-113 (high in Zn & Fe) (2.72%). However, which was found on far with G_2: IP-17720 (medium in Zn & Fe) (2.50%). Among micronutrient applications M_7: Soil application of $ZnSO_4$ @ 15 kg ha^{-1} & $FeSO_4$ @ 10 kg ha^{-1} + Foliar application of 0.5% $ZnSO_4$ and $FeSO_4$ each recorded significantly higher total potassium content (3.01%) as compared to the other treatments. Better absorption of nutrients due to higher nutrient concentration of nutrients in soil. Similar trend was noticed by Zeidan *et al.* (2010). The beneficial effect of soil and foliar application of micronutrients (Zn and Fe) at grain filling stage increased photosynthetic pigments and N, P and K concentration in grain due to enhanced the plant absorption of N, P and K thereby increasing the concentration in grain has been reported by Latha *et al.* (2001) [3].

The concentration of zinc in grain, stover and total zinc concentration of pearlmillet genotypes G_3: HFeZn-113 (high in Zn & Fe) (29.56, 38.89 and 66.45 ppm, respectively). Among micronutrients application, significantly higher zinc concentration in M_7: Soil application of $ZnSO_4$ @ 15 kg ha^{-1} & $FeSO_4$ @ 10 kg ha^{-1} + Foliar application of 0.5% $ZnSO_4$ and $FeSO_4$ each recorded significantly higher zinc concentration in grain, stover and total concentration (33.50, 45.39 and 78.72 ppm, respectively) and also concentration of iron in grain, stover and total iron concentration of pearlmillet genotypes, G_3: HFeZn-113 (high in Zn & Fe) (177.18, 166.71 and 342.26 ppm, respectively). Among micronutrients application, significantly higher iron concentration in M_7: Soil application of $ZnSO_4$ @ 15 kg ha^{-1} & $FeSO_4$ @ 10 kg ha^{-1} + Foliar application of 0.5% $ZnSO_4$ and $FeSO_4$ each recorded significantly higher iron concentration (195.45, 182.18 and 377.68 ppm, respectively) as compared to other treatments. Similar trend was followed by yang *et al.* (2011) [5]. This might be due to increase in grain yield due to increase the concentration of these micronutrient (Zn and Fe), the effect of soil and foliar application of $ZnSO_4$ and $FeSO_4$ for better absorption and enhancing the availability these micronutrients during throughout growth period.

Significantly higher availability of nitrogen, phosphorus and potassium (303.15, 30.58 and 286.91 kg ha^{-1}) was recorded in the plots grown with genotypes G_3: HFeZn-113 (high in Zn & Fe) as compared to G_1: HFeZn-102 (low in Zn & Fe) (280.22, 25.53 and 287.14 kg ha^{-1}). Among micronutrient applications significantly influenced the availability of nitrogen, phosphorus and potassium in the soil the treatment with M_7: Soil application of $ZnSO_4$ @ 15 kg ha^{-1} and $FeSO_4$ @ 10 kg ha^{-1} + Foliar application of 0.5% $ZnSO_4$ and $FeSO_4$ each (323.45, 35.50 and 318.12 kg ha^{-1}) compared to the other treatments, *viz*., control (270.52, 21.88 and 274.91 kg ha^{-1}). This mainly because of the soil and foliar application of $ZnSO_4$ and $FeSO_4$ along with recommendation inorganic fertilizer may increases the better utilization of nutrients mainly due to its beneficial or synergist effect in mobilizing the native nutrients to increase their availability these might be the reason for more available N, P and K in the soil at harvest. (Latha *et al*., 2001) [3]

The significantly higher availability of zinc and iron was recorded in the plots under G_3: HFeZn-113 (high in Zn & Fe) (2.00 and 7.74 mg kg^{-1}), compared to G_1: HFeZn-102 (low in

Zn & Fe) (1.72 and 7.38 mg kg-1), which was found on far with G_2: IP-17720 (medium in Zn & Fe) (1.85 and 7.63 mg kg-1). Among micronutrients application significantly higher availability of zinc and iron in the soil was recorded with M_7: Soil application of $ZnSO_4$ @ 15 kg ha-1 & $FeSO_4$ @ 10 kg ha-1 + Foliar application of 0.5% $ZnSO_4$ and $FeSO_4$ each (2.79 and 8.50 mg kg-1) as compared to other treatments, *viz.*, Control (1.11 and 6.78 mg kg-1). This might be due to lower uptake of nutrients and lower grain and straw yield, which leads to lower utilization of nutrients present in soil and makes more availability to the next subsequent crop. The soil and foliar application of $ZnSO_4$ and $FeSO_4$ along with recommended chemical fertilizer and FYM may increases the utilization of nutrients mainly due to its beneficial effect in mobilizing the native nutrients to increases their uptake and ultimately leads to lower availability in soil after the harvest. Similar results were observed by Basavaraj *et al.* (1995) [2].

Table 1: Total nitrogen, phosphorus and potassium content in pearlmillet (grain & stover) as influenced by genotypes and agronomic biofortification

Micronutrients application (M)	Genotypes (G)											
	Total nitrogen				Total phosphorus				Total potassium			
	G_1	G_2	G_3	Mean	G_1	G_2	G_3	Mean	G_1	G_2	G_3	Mean
M_1: Control	2.44	2.68	2.80	2.64	0.43	0.73	0.87	0.68	2.13	2.27	2.41	2.27
M_2: Seed treatment with 1% $ZnSO_4$ & $FeSO_4$ each	2.63	2.98	3.29	2.97	0.85	0.93	0.96	0.92	2.32	2.42	2.51	2.42
M_3: Soil application of $ZnSO_4$ @ 15 kg ha-1 & $FeSO_4$ @ 10 kg ha-1	3.34	3.74	4.01	3.70	1.08	1.12	1.12	1.11	2.39	2.61	2.70	2.57
M_4: Foliar application of 0.5% $ZnSO_4$ & $FeSO_4$ each at 30 and 45 DAS	2.77	3.29	3.54	3.20	0.92	1.04	1.04	1.00	2.18	2.44	2.39	2.34
M_5: Seed treatment + Soil application	3.60	4.00	4.24	3.95	1.12	1.16	1.23	1.17	2.53	2.75	2.77	2.68
M_6: Seed treatment + Foliar application	3.09	3.57	3.69	3.45	0.97	1.08	1.08	1.05	2.42	2.29	2.58	2.43
M_7: Soil application + Foliar application	3.99	4.25	4.62	4.29	1.92	2.19	2.25	2.12	2.67	2.69	3.67	3.01
Mean	3.12	3.50	3.74	-	1.04	1.15	1.37	-	2.38	2.50	2.72	-
For comparing means of	S.Em±		C.D. at 5%		S.Em±		C.D. at 5%		S.Em±		C.D. at 5%	
Genotypes (G)	0.58		2.27		0.29		1.12		0.33		NS	
Micronutrients application (M)	0.03		0.09		0.06		0.16		0.03		NS	
M at the same level of G	0.05		NS		0.10		NS		0.04		NS	
G at the same or different levels of M	0.07		NS		0.14		NS		0.06		NS	

Note: 1. G_1: HFeZn-102 (low in Zn & Fe), G_2: IP-17720 (medium in Zn & Fe) and G_3: HFeZn-113 (high in Zn & Fe). NS - Non Significant
2. RDF is common to all the treatment from M_1 and M_7

Table 2: Zinc concentration in pearlmillet grain, stover and total zinc concentration as influenced by genotypes and agronomic biofortification

Micronutrients application (M)	Genotypes (G)											
	Grain (ppm)				Stover (ppm)				Total zinc concentration (ppm)			
	G_1	G_2	G_3	Mean	G_1	G_2	G_3	Mean	G_1	G_2	G_3	Mean
M_1: Control	21.77	23.27	25.43	23.49	29.75	30.28	31.75	30.59	51.52	53.55	55.53	53.10
M_2: Seed treatment with 1% $ZnSO_4$ & $FeSO_4$ each	22.27	25.27	27.77	25.10	31.58	34.58	38.83	35.00	53.85	59.85	66.60	60.10
M_3: Soil application of $ZnSO_4$ @ 15 kg ha-1 & $FeSO_4$ @ 10 kg ha-1	26.17	27.83	28.17	27.39	37.67	39.33	41.00	39.33	63.83	67.17	69.17	66.72
M_4: Foliar application of 0.5% $ZnSO_4$ & $FeSO_4$ each at 30 and 45 DAS	23.33	22.43	22.67	22.81	31.75	35.58	37.75	35.03	55.08	58.02	60.42	57.84
M_5: Seed treatment + Soil application	29.00	32.67	35.67	32.44	40.33	40.75	43.33	42.14	69.75	73.00	78.00	73.58
M_6: Seed treatment + Foliar application	24.77	27.50	30.17	27.48	32.67	35.67	38.58	35.64	57.43	63.17	68.75	63.12
M_7: Soil application + Foliar application	33.77	34.00	35.50	33.50	44.00	46.28	47.00	45.39	81.35	82.75	84.07	78.72
Mean	26.01	28.02	29.56	-	34.68	36.62	38.89	-	60.69	63.64	66.45	-
For comparing means of	S.Em±		C.D. at 5%		S.Em±		C.D. at 5%		S.Em±		C.D. at 5%	
Genotypes (G)	0.31		1.23		0.97		3.79		1.01		6.95	
Micronutrients application (M)	0.66		1.90		0.66		1.90		0.95		2.71	
M at the same level of G	1.15		NS		1.15		NS		1.64		NS	
G at the same or different levels of M	1.62		NS		1.63		NS		2.32		NS	

Note: 1. G_1: HFeZn-102 (low in Zn & Fe), G_2: IP-17720 (medium in Zn & Fe) and G_3: HFeZn-113 (high in Zn & Fe). NS - Non Significant
Note: 2. RDF is common to all the treatment from M_1 and M_7

Table 3: Iron concentration in pearlmillet grain, stover and total iron concentration as influenced by genotypes and agronomic biofortification

Micronutrients application (M)	Genotypes (G)											
	Grain (ppm)				Stover (ppm)				Total iron concentration (ppm)			
	G_1	G_2	G_3	Mean	G_1	G_2	G_3	Mean	G_1	G_2	G_3	Mean
M_1: Control	142.18	144.24	146.80	144.41	124.31	128.31	130.31	127.65	266.54	272.41	277.10	272.12
M_2: Seed treatment with 1% $ZnSO_4$ & $FeSO_4$ Each	165.21	168.14	168.15	167.22	152.23	158.24	155.24	155.25	317.45	326.35	323.38	322.35
M_3: Soil application of $ZnSO_4$ @ 15 kg ha-1 & $FeSO_4$ @ 10 kg ha-1	185.24	185.12	185.18	185.20	171.24	172.29	175.12	172.90	356.36	357.41	360.31	358.15
M_4: Foliar application of 0.5% $ZnSO_4$ & $FeSO_4$ each at 30 and 45 DAS	172.15	172.15	175.20	173.24	162.21	161.15	165.18	162.88	334.38	333.39	340.25	336.09

M_5: Seed treatment + Soil application	189.16	191.13	188.10	190.12	174.18	175.14	179.19	176.75	363.45	366.32	366.14	366.65
M_6: Seed treatment + Foliar application	176.75	178.25	179.18	178.14	165.14	168.32	171.17	168.21	342.21	346.25	350.21	346.25
M_7: Soil application + Foliar application	194.12	195.32	197.21	195.45	180.22	182.18	184.23	182.18	374.45	377.12	381.14	377.68
Mean	175.10	176.31	177.18	-	161.43	163.72	166.71	-	336.34	340.10	342.26	-
For comparing means of	S.Em±		C.D. at 5%		S.Em±		C.D. at 5%		S.Em±		C.D. at 5%	
Genotypes (G)	1.46		5.73		1.41		5.54		2.83		11.10	
Micronutrients application (M)	0.24		0.68		0.58		1.66		0.59		1.69	
M at the same level of G	0.41		NS		1.00		NS		1.02		NS	
G at the same or different levels of M	0.58		NS		1.42		NS		1.45		NS	

Note: 1. G_1: HFeZn-102 (low in Zn & Fe), G_2: IP-17720 (medium in Zn & Fe) and G_3: HFeZn-113 (high in Zn & Fe). NS - Non Significant
Note: 2. RDF is common to all the treatment from M_1 and M_7

Table 4: Available nitrogen, phosphorus and potassium status in soil after harvest of crop as influenced by genotypes and agronomic biofortification

Micronutrients application (M)	Genotypes (G)											
	Nitrogen (kg ha^{-1})				Phosphorus (kg ha^{-1})				Potassium (kg ha^{-1})			
	G_1	G_2	G_3	Mean	G_1	G_2	G_3	Mean	G_1	G_2	G_3	Mean
M_1: Control	268.22	270.54	273.20	270.52	20.15	21.30	24.20	21.88	275.10	273.21	276.80	274.91
M_2: Seed treatment with 1% $ZnSO_4$ & $FeSO_4$ Each	280.15	279.25	284.23	281.21	25.77	26.34	26.37	26.16	278.32	289.62	285.61	284.52
M_3: Soil application of $ZnSO_4$ @ 15 kg ha^{-1} & $FeSO_4$ @ 10 kg ha^{-1}	303.09	305.74	309.08	307.25	24.63	27.33	31.47	28.48	285.63	304.50	309.75	301.64
M_4: Foliar application of 0.5% $ZnSO_4$ & $FeSO_4$ each at 30 and 45 DAS	188.24	294.22	299.29	260.56	22.67	25.00	27.67	25.11	277.15	287.81	198.66	254.50
M_5: Seed treatment + Soil application	309.45	313.30	321.07	315.50	27.97	31.97	35.60	31.84	299.64	310.62	315.61	309.91
M_6: Seed treatment + Foliar application	294.12	304.18	304.51	301.18	23.30	25.67	29.07	26.01	281.31	292.18	303.16	292.23
M_7: Soil application + Foliar application	317.25	321.14	332.15	323.45	34.23	36.30	39.67	35.50	314.09	319.11	321.08	318.12
Mean	280.22	298.09	303.15	-	25.53	27.60	30.58	-	287.14	296.26	286.91	-
For comparing means of	S.Em±		C.D. at 5%		S.Em±		C.D. at 5%		S.Em±		C.D. at 5%	
Genotypes (G)	2.10		8.23		0.99		3.90		2.32		9.09	
Micronutrients application (M)	1.29		3.71		1.01		2.89		1.13		3.24	
M at the same level of G	2.24		NS		1.74		NS		1.96		NS	
G at the same or different levels of M	3.17		NS		2.47		NS		2.77		NS	

Note: 1. **G_1**: HFeZn-102 (low in Zn & Fe), **G_2**: IP-17720 (medium in Zn & Fe) and **G_3**: HFeZn-113 (high in Zn & Fe). NS - Non Significant
2. RDF is common to all the treatment from M_1 and M_7

Table 5: Available micronutrients (Zinc and Iron) status in soil after harvest of crop as influenced by genotypes and agronomic biofortification

Micronutrients application (M)	Genotypes							
	Zn (mg kg^{-1})				Fe (mg kg^{-1})			
	G_1	G_2	G_3	Mean	G_1	G_2	G_3	Mean
M_1: Control	1.05	1.11	1.18	1.11	6.15	7.02	7.18	6.78
M_2: Seed treatment with 1% $ZnSO_4$ & $FeSO_4$ each	1.21	1.28	1.45	1.31	7.1	7.21	7.29	7.20
M_3: Soil application of $ZnSO_4$ @ 15 kg ha^{-1} & $FeSO_4$ @ 10 kg ha^{-1}	2.20	2.45	2.55	2.40	7.76	7.81	7.94	7.84
M_4: Foliar application of 0.5% $ZnSO_4$ & $FeSO_4$ each at 30 and 45 DAS	1.25	1.39	1.57	1.40	7.14	7.37	7.41	7.31
M_5: Seed treatment + Soil application	2.3	2.51	2.67	2.49	7.95	7.99	8.15	8.03
M_6: Seed treatment + Foliar application	1.37	1.47	1.64	1.49	7.29	7.46	7.51	7.42
M_7: Soil application + Foliar application	2.67	2.75	2.95	2.79	8.25	8.57	8.68	8.50
Mean	1.72	1.85	2.00	-	7.38	7.63	7.74	-
For comparing means of	S.Em±		C.D. at 5%		S.Em±		C.D. at 5%	
Genotypes (G)	0.12		0.39		0.14		0.45	
Micronutrients application (M)	0.05		0.18		0.10		0.35	
M at the same level of G	0.01		NS		0.01		NS	
G at the same or different levels of M	0.02		NS		0.01		NS	

Note: 1. G_1: HFeZn-102 (low in Zn & Fe), G_2: IP-17720 (medium in Zn & Fe) and G_3: HFeZn-113 (high in Zn & Fe). NS - Non Significant
Note: 2. RDF is common to all the treatment from M_1 and M_7

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