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Soil nutrient status as influenced by different micronutrient management practices in pearl millet cultivars

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Abstract
Two field experiments were conducted during *Kharif*, 2018 and 2019 on clay loam soils at Zonal Agricultural and Horticultural Research Station, Babbur farm, Hiriyur, Karnataka to estimate the post harvest soil nutrient status in pearl millet cultivated plots. Micronutrient (Zn and Fe) management strategies include application of NPK, deficit iron and zinc through soil, foliar application and FYM enriched with iron and zinc along with PGPR in main plots and three pearl millet cultivars ICTP 8203 Fe (Dhanshakti), ICMH 1202 and WCC 75 (local cultivar) as sub plots laid in split plot design replicated thrice. As compared to the initial soil status, the availability of N, P_2O_5 and K_2O was reduced, while Zn and Fe availability increased in micronutrient applied treatments. The study confirmed that after two years of experimentation, the soil available N (242 kg ha^{-1}), P_2O_5 (27 kg ha^{-1}) and K_2O (286 kg ha^{-1}) was higher with RDF alone (F_1) than other micronutrient management practices, while enriched FYM + PGPR (F_4) and soil application (F_2) treatments were on par with each other and retained higher soil available Zn (0.60 and 0.59 ppm) and Fe (4.0 and 3.80 ppm), respectively. Plots with local cultivar WCC 75 (G_3) revealed significantly higher availability of nitrogen (243 kg ha^{-1}) and micronutrients (0.47 and 3.70 ppm Zn and Fe, respectively) in the soil over other two pearl millet cultivars.

Keywords: enriched FYM, iron, pearl millet cultivars and zinc

Introduction
The advancement of agricultural research has remarkably boosted crop yields in all the agrarian regions at the cost of intensified ecological and soil degradation problems. In India, the arid and semi arid areas occupy more than 60 per cent of the cultivated area and contributes around 40 per cent of the food production (Prasad *et al.*, 2015) [8]. Sustainable food production from harsh environments of semi arid tropics with scarce water resources coupled with inherent poor soils is one of the most significant challenges. The focused research that emphasized on increasing crop production in these thirsty and hungry soils includes high yielding varieties with intensive fertilizer use and reduced application of organic manures have largely depleted major and micronutrients and left the soils to the level of deficiency. In these regions, depletion of soil fertility and their imbalances is a severe global threat leaving large yield gaps between current farmers and achievable ones. Hence, these micronutrients application decides the yield potential of crops in deficient soils with low organic carbon content.

Pearl millet is an indispensable dual purpose crop of arid and semi arid climatic regions of the world. It is the world's hardiest warm season crop and one of the staple foods for the poor. In India, it occupies an area of 7.11 m ha accounting for 8.66 m t production (Anon., 2019) [1]. Balanced application of all the essential nutrients is vital for healthy and vigorous crops to meet achievable yields. The biofortified cultivars of pearl millet inherently capacitated for higher uptake and accumulation of micronutrients, especially Zn and Fe, which were to be complemented through agronomic means in the deficient soils. It can be met by widely practiced soil application and in plants by foliar means. Organic manures are natural sources of major and micronutrients produces various organic acids during microbial decomposition and converts the plant nutrients from immobile to mobile in soil solution. Further enrichment of organic manures with micronutrients facilitates high chelation and slow availability of nutrients by forming the organic complexes with the nutrients applied, thereby preventing fixation and precipitation losses leading to enhanced use efficiencies of applied fertilizers. On the other hand, biofertilizers keep the soil environment rich in all kinds of micro and macronutrients through mineralization and solubilization of different nutrients. They facilitate the release of plant growth promoting substances, biodegradation of organic matter in the soil, better nutrient uptake and increased tolerance towards drought and moisture stress. Individual or co-inoculation of these plant growth promoting micro-organisms act synergistically and convert unavailable forms of nutrients to available forms.

Material and Methods

Field experiments were conducted during *Kharif*, 2018 and 2019 on clay loam soils at Zonal Agricultural and Horticultural Research Station, Babbur farm, Hiriyur, Chitradurga district, Karnataka. The geographical reference point of the experimental site was 13º 94' 38" North latitude and 76º 61'61" East longitude, with an altitude of 630 meters above mean sea level (MSL). It comes under the Agro-Climatic Region-10 and Central Dry Zone (Zone-IV) of Karnataka which is categorized under semi arid tropics. The soil of the study was moderately alkaline in reaction (8.10 pH) with a normal electrical conductivity (0.86 dSm^{-1}) and low in organic carbon (1.92 g kg^{-1}). Further, the soil is low in available nitrogen status (259 kg ha^{-1}), medium status for available P_2O_5 (34 kg ha^{-1}) and available K_2O (314 kg ha^{-1}). The experimental site was respectively deficient in Zn (0.31 ppm) and Fe (3.62 ppm).

The experiment was laid out in split plot design with four micronutrient (Zn and Fe) management strategies as main plots *viz.*, F_1: Control (Recommended dose of N, P and K), F_2: Recommended dose of FYM + N, P, K and management of deficit iron and zinc through soil application, F_3: Recommended dose of FYM + N, P, K and management of deficit iron and zinc through foliar application and F_4: Recommended dose of FYM enriched with deficit iron and zinc + recommended N, P, K + PGPR and three pearl millet cultivars, *viz.*, ICTP 8203 Fe (Dhanshakti) (G_1), ICMH 1202 (G_2) and WCC 75 (local cultivar) (G_3) as sub plots. ICTP 8203 Fe and ICMH 1202 are biofortified variety and hybrid, respectively developed from ICRISAT. These twelve treatment combinations were replicated thrice in the experiment and the crop spacing adopted was 45 cm X 15 cm.

The recommended dose of FYM was applied @ 7.5 t ha^{-1} two weeks before sowing for all the treatments as per the nutrient management practices planned across two years except for the plots with enriched FYM. FYM was enriched with the addition of $ZnSO_4$ (20 kg ha^{-1}) and $FeSO_4$ (10 kg ha^{-1}), cured for 15 days under a shade and applied to the prescribed treatments. The basal recommended dose of fertilizers (50:25:0 kg N, P_2O_5 and K_2O ha^{-1}) in the form of urea (46 % N) and single super phosphate (16 % P_2O_5) were applied as per the treatments. In micronutrient management practices, soil application of $ZnSO_4$ (20 kg ha^{-1}) and $FeSO_4$ (10 kg ha^{-1}) was done two weeks after sowing the crop to avoid antagonism between phosphorus and zinc. The foliar application of both the micronutrients (Zn-0.2 % & Fe-0.5 %) was carried out at 35 and 55 DAS. The treatments involving PGPR and enriched FYM, seed treatment was carried out with microbial consortia (*Azospirillum*, phosphate solubilizing bacteria and potassium solubilizing bacteria) and enriched FYM with zinc and iron was applied after curing before sowing of the crop.

The soil samples were drawn from 0 to 15 cm depth before sowing and after harvest of the crop. Samples were air dried, powdered, sieved using a two mm sieve and stored in poly bags for further analysis. Soil pH and organic carbon were analysed using potentiometry (Jackson, 1973) [3] and wet oxidation (Walkley and Black, 1934) [12] method, respectively. The soil available nitrogen was estimated by alkaline potassium permanganate method (Subbiah and Asija, 1956) [11], available P_2O_5 by Olsen's extractant method (Jackson, 1973) [3] and available K_2O by neutral normal ammonium acetate method (Jackson, 1973) [3]. The available micronutrients Zn and Fe were estimated through DTPA extractant by AAS method (Lindsay and Norwell, 1978) [6]. The data on different parameters collected was subjected to analysis of variance and explained in the following paragraphs.

Results and Discussion

The soil reaction and organic carbon content at harvest of pearl millet indicated minor differences compared to initial status (8.10 and 1.92 g kg^{-1}), respectively. Further it was found that they were comparable among the treatments in the study (Table 2) with slight improvement in the organic carbon in plots treated with the application of enriched FYM with Zn and Fe along with PGPR. The data pertaining to available N, P_2O_5, K_2O, Zn and Fe status of soil after harvest of pearl millet as influenced by cultivars and micronutrient management practices is furnished in Table 3 and 4, respectively. The results revealed that the available nitrogen, phosphorus, potassium, iron and zinc were significantly varied among the treatments. In the treatments with higher yields the major nutrient availability was found lower due to the higher uptake and biomass production (Table 1).

Before initiating the experiment, major nutrients recorded 259, 34 and 314 kg ha^{-1}, respectively, for nitrogen, phosphorus and potassium. After the first year of study, nitrogen reduced to significant level of 218 kg ha^{-1} but succeeding year more or less no further reduction was observed. On the similar lines, phosphorus and potassium also reduced from 34 and 314 kg ha^{-1} to 23 and 260 kg ha^{-1}, respectively, however the values did not reduce further in the second year of experimentation in the plots that received farm yard manure apart from recommended

Table 1: Yields and harvest index of pearl millet cultivars as influenced by different micronutrient management practices

Treatments	Grain yield (kg ha^{-1})			Straw yield (kg ha^{-1})			Biological yield (kg ha^{-1})			Harvest index (%)		
	2018	2019	Pooled	2018	2019	Pooled	2018	2019	Pooled	2018	2019	Pooled
Main plots (micronutrient management practices)												
F_1	1575	1792	1684	3600	3965	3782	5175	5758	5466	30.26	31.11	30.68
F_2	1698	1983	1841	3885	4239	4062	5583	6221	5902	30.33	31.87	31.10
F_3	1617	1977	1797	3630	4160	3895	5247	6136	5692	30.73	32.23	31.48
F_4	1748	2090	1919	3940	4463	4202	5688	6553	6121	30.66	31.83	31.24
S. Em±	28.3	24.2	18.6	77.6	76.3	60.3	103.6	93.7	75.0	0.20	0.29	0.22
CD (P=0.05)	99	86	66	274	269	213	365	331	265	NS	NS	NS
Sub plots (Cultivars)												
G_1	1814	1936	1875	4121	4254	4188	5935	6191	6063	30.58	31.31	30.94
G_2	1906	2288	2097	4155	4780	4468	6060	7069	6565	31.44	32.35	31.90
G_3	1259	1656	1458	3015	3586	3301	4275	5242	4759	29.46	31.06	30.26

S. Em±	30.9	27.2	18.6	57.4	69.7	42.7	81.7	77.2	55.4	0.32	0.45	0.22
CD (P=0.05)	94	82	56	174	211	129	247	233	168	0.95	NS	0.66
Interaction (F × G)												
F_1G_1	1730	1794	1762	3956	4040	3998	5686	5834	5760	30.43	30.77	30.60
F_1G_2	1853	2044	1948	4010	4421	4216	5863	6465	6164	31.59	31.62	31.60
F_1G_3	1143	1539	1341	2832	3435	3133	3975	4973	4474	28.75	30.93	29.84
F_2G_1	1838	1927	1883	4175	4212	4194	6013	6140	6076	30.60	31.38	30.99
F_2G_2	1920	2328	2124	4259	4944	4601	6178	7272	6725	31.06	32.00	31.53
F_2G_3	1336	1693	1514	3221	3560	3390	4557	5253	4905	29.32	32.25	30.78
F_3G_1	1785	1893	1839	3953	4173	4063	5738	6065	5902	31.11	31.37	31.24
F_3G_2	1856	2372	2114	4089	4812	4451	5945	7184	6565	31.22	33.01	32.12
F_3G_3	1211	1666	1439	2848	3494	3171	4059	5160	4610	29.86	32.31	31.09
F_4G_1	1902	2131	2017	4400	4592	4496	6302	6724	6513	30.17	31.72	30.94
F_4G_2	1995	2410	2203	4260	4944	4602	6255	7354	6805	31.90	32.77	32.33
F_4G_3	1347	1729	1538	3160	3854	3507	4507	5583	5045	29.91	31.00	30.46
S. Em±	57.9	50.6	35.6	121.8	137.0	92.1	168.9	157.1	117.6	0.55	0.79	0.42
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 2: Soil pH and organic carbon (g kg^{-1}) at harvest of pearl millet cultivars as influenced by different micronutrient management practices

Treatments	pH		OC (g kg^{-1})	
	2018	2019	2018	2019
Main plots (Micronutrient management practices)				
F_1	8.09	8.07	1.93	1.93
F_2	8.08	8.05	1.94	1.95
F_3	8.09	8.08	1.93	1.94
F_4	8.06	7.97	1.95	1.95
S. Em±	0.05	0.04	0.01	0.01
CD (P=0.05)	NS	NS	NS	NS
Sub plots (Cultivars)				
G_1	8.08	8.06	1.94	1.94
G_2	8.07	8.04	1.94	1.94
G_3	8.09	8.03	1.94	1.95
S. Em±	0.12	0.13	0.01	0.04
CD (P=0.05)	NS	NS	NS	NS
Interaction (F X G)				
F_1G_1	8.09	8.08	1.93	1.94
F_1G_2	8.09	8.08	1.94	1.93
F_1G_3	8.08	8.07	1.93	1.93
F_2G_1	8.08	8.08	1.94	1.95
F_2G_2	8.08	8.03	1.93	1.94
F_2G_3	8.09	8.05	1.94	1.95
F_3G_1	8.09	8.05	1.93	1.93
F_3G_2	8.10	8.10	1.94	1.95
F_3G_3	8.08	8.09	1.93	1.94
F_4G_1	8.05	8.02	1.95	1.95
F_4G_2	8.02	7.97	1.94	1.95
F_4G_3	8.10	7.92	1.95	1.96
S. Em±	0.12	0.22	0.01	0.06
CD (P=0.05)	NS	NS	NS	NS

Initial soil pH - 8.10, soil organic carbon - 1.92 g kg^{-1}

NPK except first treatment. For biomass production, the inorganic fertilizers paved higher contribution along with the native availability, while decomposition of manure to available nutrient status being a slow process added continuously to the soil pool directly helped to sustain the soil health (Rekha *et al*., 2018) [10].

Among the treatments, after two years, the soil available N and K_2O (242 and 286 kg ha^{-1}, respectively) were significantly higher with RDF alone (F_1) than other micronutrient management practices, while P_2O_5 was comparable among them. The application of recommended FYM enriched with deficit iron and zinc + recommended NPK + PGPR (F_4) and soil application of iron and zinc along with recommended FYM + NPK (F_2) witnessed significantly lower levels of soil available N (226 kg ha^{-1}) as well as K_2O (268 and 271 kg ha^{-1}, respectively) and was on par with each other (Table 3). Compared to the initial readings (0.31 ppm for Zn and 3.62 ppm for Fe) of the experimentation, after harvest of the crop in each successive years, the retention of the selected micronutrients was found higher (0.29 to 0.60 ppm for Zn and 3.07 to 4.00 ppm for Fe). In that, the micronutrient applied plots had a higher retentivity (Table 4). The data inferred that higher soil micronutrient (Zn and Fe) status was observed with the application of recommended FYM enriched with deficit iron and zinc + recommended NPK + PGPR (F_4) (0.60 and 4.00 ppm Zn and Fe, respectively) which was on par with the soil application of deficit iron and zinc along with recommended FYM + NPK (F_2) (0.59 and 3.80 ppm Zn and Fe, respectively).

Among the pearl millet cultivar plots, lower (226, 24 and 272 kg ha^{-1} N, P_2O_5 and K_2O, respectively) availability of major nutrients was observed in ICMH 1202 (G_2) hybrid plots and higher (243, 27 and 285 kg ha^{-1} N, P_2O_5 and K_2O, respectively) with WCC 75 (G_3) cultivar plots. Further higher soil available Zn and Fe of 0.47 and 3.70 ppm, respectively, were recorded with WCC 75 (G_3) cultivar and significantly lower values with ICMH 1202 (G_2) (0.42 and 3.38 ppm Zn and Fe, respectively) and ICTP 8203 Fe (G_1) (0.44 and 3.46 ppm Zn and Fe, respectively) cultivars in the study.

The soil nutrient status altered among the different nutrient management practices and cultivars based on the nutrient demand and uptake of the nutrients. The micronutrient application through enriched FYM and PGPR application in ICMH 1202 (2203 kg ha^{-1}) and ICTP 8203 Fe

Table 3: Soil nutrient status at harvest of pearl millet cultivars as influenced by different micronutrient management practices

Treatments	Available N (kg ha^{-1})		Available P_2O_5 (kg ha^{-1})		Available K_2O (kg ha^{-1})	
	2018	2019	2018	2019	2018	2019
Main plots (Micronutrient management practices)						
F_1	241	242	29	27	285	286
F_2	227	226	23	23	273	271
F_3	237	235	27	27	278	277
F_4	226	226	26	26	268	268
S. Em±	2.3	1.4	1.4	1.2	1.6	1.6
CD (P=0.05)	8	5	NS	NS	6	6
Sub plots (Cultivars)						
G_1	230	229	26	26	274	270
G_2	226	226	25	24	269	272
G_3	242	243	27	27	286	285
S. Em±	4.2	3.9	1.4	1.5	4.7	4.7
CD (P=0.05)	13	12	NS	NS	NS	NS
Interaction (F X G)						
F_1G_1	237	240	29	26	283	285
F_1G_2	237	235	28	25	277	284
F_1G_3	249	252	31	30	295	290
F_2G_1	224	225	23	23	269	266
F_2G_2	218	220	23	22	268	264
F_2G_3	240	235	23	24	281	283
F_3G_1	236	231	27	28	274	269
F_3G_2	232	230	25	27	270	276
F_3G_3	241	245	29	26	290	287
F_4G_1	222	221	25	25	268	262
F_4G_2	218	219	24	24	260	263
F_4G_3	239	240	27	29	277	281
S. Em±	7.3	6.6	2.6	2.8	7.8	7.8
CD (P=0.05)	NS	NS	NS	NS	NS	NS

Initial soil available N, P_2O_5 and K_2O - 259, 34 and 314 kg ha^{-1}, respectively

Table 4: Soil micronutrient status at harvest of pearl millet cultivars as influenced by different micronutrient management practices

Treatments	DTPA extractable Zn (ppm)		DTPA extractable Fe (ppm)	
	2018	2019	2018	2019
Main plots (Micronutrient management practices)				
F_1	0.32	0.29	3.39	3.07
F_2	0.55	0.59	3.80	3.80
F_3	0.32	0.30	3.32	3.17
F_4	0.57	0.60	3.79	4.00
S. Em±	0.01	0.01	0.03	0.10
CD (P=0.05)	0.04	0.02	0.11	0.35
Sub plots (Cultivars)				
G_1	0.44	0.44	3.53	3.46
G_2	0.43	0.42	3.47	3.38
G_3	0.46	0.47	3.72	3.70
S. Em±	0.01	0.01	0.07	0.08
CD (P=0.05)	0.03	0.03	0.20	0.25
Interaction (F × G)				
F_1G_1	0.32	0.25	3.35	3.07
F_1G_2	0.31	0.29	3.30	2.82
F_1G_3	0.34	0.33	3.52	3.33
F_2G_1	0.55	0.61	3.78	3.79
F_2G_2	0.53	0.56	3.71	3.77
F_2G_3	0.57	0.60	3.92	3.85
F_3G_1	0.31	0.29	3.25	3.05

F_3G_2	0.30	0.28	3.19	3.05
F_3G_3	0.35	0.34	3.51	3.42
F_4G_1	0.58	0.61	3.75	3.91
F_4G_2	0.56	0.59	3.69	3.90
F_4G_3	0.59	0.61	3.93	4.19
S. Em±	0.02	0.02	0.11	0.17
CD (P=0.05)	NS	NS	NS	NS

Initial soil available Zn – 0.31 ppm and Fe – 3.62 ppm

(2017 kg ha^{-1}) performed better in the study (Table 1). The treatment which received FYM enriched with zinc and iron along with recommended NPK recorded lower soil available major nutrients because higher growth and yield were achieved, hence nutrient demand was higher in this treatment. At the same time, higher available major nutrients in soil was observed with control treatment due to its lower growth and less nutrient demand for uptake. Further, status of phosphorus was lower in the soil application of micronutrients due to the fact that extreme reactivity of the P, soil pH dictation, soil CEC apart from antagonism between phosphorus and zinc resulting zinc phosphate complexes and reduced the availability of both the nutrients in the soil, thereby paves the way for higher retention. The enrichment process and soil application of micronutrients resulted in significantly higher soil available zinc and iron over foliar application and control treatments due to the reason that in both the treatments, soil is not supplemented with micronutrients. In the enrichment method of micronutrient application, curing process resulted in chelated forms of nutrients that were hardly available for fixation or precipitation. *Azospirillum* excretes ammonia into the rhizosphere in the presence of root exudates, production of organic acids quickly dissolves the potassium from its bearing rocks/ parent material leading to release of potassium ions into the soil solution and PSB also solubilize the native forms of phosphorus through their microbial processes. Hence even the uptake was significantly higher, nutrient status was not reduced drastically in the pace of nutrient uptake with this particular treatment. Therefore enriched FYM and PGPR improved the nutrient uptake and reduced the load on direct soil application of nutrients.

The biofortified hybrid ICMH 1202 (G_2) and biofortified variety ICTP 8203 Fe (G_1) resulted in significantly lower soil availability of N, Zn and Fe due to their inherent capacity for higher accumulation of Zn and Fe and higher dry matter production. Hence soil availability of nutrients was lower as plant uptake was higher. Further, WCC 75 (G_3) reported higher nutrient status over the other improved cultivars due to its lower nutrient demand and accumulation capacity thus, soil possessed higher nutrient content. The results of soil nutrient status were confirmed with findings of Fulpagare *et al*. (2018) [2], Meena *et al.* (2018) [7], Rekha *et al.* (2018) [10], Rani *et al*. (2017) [9], Kannan *et al*. (2014) [4] and Kanzaria *et al*. (2010) [5].

Conclusion

The micronutrient application through enriched FYM and PGPR application across the pearl millet cultivar treated plots was found better in improving the soil micronutrient status.

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References

1. Anonymus. Area, production and productivity of bajra in India 2019. http://www.indiastat.com.
2. Fulpagare DD, Patil TD, Thakare RS. Effect of application of iron and zinc on nutrient availability and pearl millet yield in Vertisols. Int. J Chem. Stud 2018;6(6):2647-2650.
3. Jackson ML. Soil chemical analysis, (Ed.). Prentice-Hall of India Pvt. Ltd., New Delhi 1973.
4. Kannan P, Arunachlam P, Prabukumar G, Prabhaharan J. Response of blackgram (*Vigna mungo* L.) to multi-micronutrient mixtures under rainfed Alfisol. J Indian Soc. Soil Sci 2014;62(2):154-160.
5. Kanzaria KK, Sutaria GS, Akbari KN, Vora VD, Padmani DR. Effect of integrated nutrient management on productivity of pearl millet and soil fertility of sandy loam soils under rainfed conditions. Asian J Soil Sci 2010;5(1):154-156.
6. Lindsay WL, Norwell WA. Development of DTPA soil test for Zn, Fe, Mn and Cu. American Soil Sci. Soc. J 1978;42:421-428.
7. Meena BL, Kumar P, Kumar A, Meena RL, Kaledhonkar MJ, Sharma PC. Zinc and iron nutrition to increase the productivity of pearl millet-mustard cropping system in salt affected soils. Int. J Curr. Microbiol. App. Sci 2018;7(8):3201-3211.
8. Prasad SK, Singh R, Singh MK, Rakshit A. Zinc biofortification and agronomic indices of pearl millet under semi-arid region. Int. J Agric. Environ Biotechnol 2015;8(1):171-175.
9. Rani YS, Triveni U, Patro TSSK, Anuradha N. Effect of nutrient management on yield and quality of finger millet (*Eleusine coracana* (L.) Gaertn). Int. J Chem. Stud 2017;5(6):1211-1216.
10. Rekha DLM, Lakshmipathy R, Gopal GA. Effect of integrated use of biofertilizers, chemical fertilizers and farmyard manure on soil health parameters of pearl millet (*Pennisetum glaucum* L.). J Soil Sci. Plant Health 2018;2(2):1-4.
11. Subbiah BV, Asija GL. Rapid procedure for estimation of available nitrogen in soils. Current Sci 1956;25:259-260.
12. Walkley A, Black CA. An examination of Degtareff method for determining soil organic matter and proposed modification of chromic titration method. Soil Sci 1934;37:29-38.