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Bhuvana K
Ph.D. Research Scholar,
Department of Soil Science and
Agricultural Chemistry, College of
Agriculture, Rajendranagar,
PJTUAU, Hyderabad, Telangana,
India

Anjaiah T
Principal Scientist, Department of
Soil Science and Agricultural
Chemistry, AICRP on Weed
management, Water Technology
Centre, Rajendranagar, PJTAU,
Hyderabad, Telangana, India

Madhavi A
Principal Scientist and Head,
Department of Soil Science and
Agricultural Chemistry, AICRP on
STCR, Institute of Soil Health
Management, Agricultural
Research Institute, PJTAU,
Rajendranagar, Hyderabad,
Telangana, India

Laxminarayana P
Professor, Department of
Agronomy, College of Agriculture,
Rajendranagar, PJTAU,
Hyderabad, Telangana, India

Corresponding Author:

Bhuvana K
Ph.D. Research Scholar,
Department of Soil Science and
Agricultural Chemistry, College of
Agriculture, Rajendranagar,
PJTUAU, Hyderabad, Telangana,
India

Deciphering micronutrient fertility of rice productivity soils using nutrient index analysis in Mahabubnagar District, Telangana

Bhuvana K, Anjaiah T, Madhavi A and Laxminarayana P

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Abstract

In order to manage natural resources, diversify crops, and boost production levels, soil fertility—particularly micronutrients evaluation in cropping systems helps to achieve potential soil productivity and long-term sustainability of the ecosystem. Thus, the present investigation was undertaken by the collection of surface soil samples (0-15 cm) from the three i.e., high, medium and low productivity rice soils of Mahabubnagar district, Telangana. The main objective was to evaluate the available micronutrients-copper, manganese, iron and zinc in the soils of the study area and develop Nutrient Index for each nutrient. Nutrient Index values of Cu were 3, 3, 2.96; Mn are 3, 2.89, 2.96; Fe are 3, 3, 2.99 and Zn are 2.08, 2.08, 1.92 for high, medium and low productivity rice soils respectively. The fertility assessment across the productivity soils demonstrated that copper, manganese, iron was present at sufficient levels, as evidenced by high Nutrient Index values across all classes unlike to the case of available zinc, which remained at a medium range, with a relatively lower index in low rice productivity soils, suggesting zinc as a potential limiting element for rice productivity. Nutrient Indices therefore helps in comparing the fertility status across rice productivity soils and thereby assists in undertaking the best nutrient management strategies and achieve the improvement in the overall rice productivity of the region.

Keywords: Soil productivity, nutrient index, cationic micronutrients, soil fertility

1. Introduction

Soil is the fundamental and vital resource for both human life and healthy agricultural production, which is rather supported by other resource namely water. The production of food, fodder, fibre, and the preservation of environmental quality all depend on soil. The natural ability of soil to support crop growth by providing necessary plant nutrients and favourable physical, chemical, and biological properties as a habitat for plant growth is known as soil fertility. Plant growth in relation to the soil's available nutrient status is indicated by the fertility status of the soil. The most fundamental tool for effectively developing a land use strategy for a specific area is soil fertility assessment (Havlin *et al.*, 2010) ^[2], and can be evaluated by soil testing. Soil testing yields information about characteristics of the soil and its available nutrient status, which serves as the foundation for fertilizer recommendation to crops. A successful nutrient management strategy for achieving sustainable soil health and crop productivity is soil test-based fertilizer application. In order to manage natural resources, diversify crops, and boost production levels, soil fertility—particularly micronutrients—must be evaluated in areas where commercial crops are grown. Because of ongoing fertilizer mining without restoration, the levels of micronutrients in soils are declining. Available nutrients in the soil, rather than their overall concentration, influence the best plant growth and achieve optimum agricultural yields (Yunas *et al.*, 2023; Prasad *et al.*, 2021; Malik *et al.*, 2017) ^[19, 10, 6].

Determination of soil micronutrient status thereby helps to address the soil productivity and long-term sustainability of the ecosystem (Manivikas *et al.*, 2022) ^[8]. According to Unified Portal for Agricultural Statistics (UPAg, 2025) ^[18], Telangana is the second largest producer of rice contributing about 174.46 lakh tonnes after Uttar Pradesh (207.59 lakh tonnes) of the India's total rice production (1501.84 lakh tonnes). Soil cationic micronutrients namely available copper (Cu), zinc (Zn), iron (Fe) and manganese (Mn) involve in their specific functions like as

a component of cytochrome oxidase, necessary for the synthesis of proteins and auxins, aiding in photosynthesis; nitrogen metabolism, carbon uptake, and photosynthesis respectively (Sagwal *et al.*, 2023, Mandavgade *et al.*, 2015) ^[14, 7]. Keeping this as viewpoint, the present study was undertaken to evaluate the micro-nutrient status across the rice productivity soils in Mahabubnagar district of Telangana.

2. Materials and Methods

2.1 Study Site, Soil Sample Collection and Laboratory Analysis

The study area includes Mahabubnagar, district of Telangana state overlying between latitudes 15° 55' and 17° 29' N and longitudes 77° 15' and 79° 15' E. The mandals of the same were classified into low (<5793 kg ha⁻¹), medium (5793-5923 kg ha⁻¹) and high (5923-6052 kg ha⁻¹) productivity regions based on the preliminary five-year records of rice production sourced from the Agriculture Office, Mahabubnagar. Further, the survey was conducted in *rabi*, 2023 and the soil samples were collected from the plough layer (0-15 cm) of rice growing regions of the study area. A total of 225 soil samples (75 each from the productivity region) were collected by the stratified random sampling method. The collected soil samples were then air-dried, grounded and passed through 2mm sieve. Available Cu, Zn, Fe and Mn levels in the soils were extracted using the Diethylene Triamine Pentaacetic Acid (DTPA) extractant and then are quantified using an atomic absorption spectrophotometer (VARIAN-AA240FS), by the method outlined by Lindsay and Norvell in 1978. Then, the data is subjected to statistical analysis (Descriptive statistics and one-way ANOVA) using Microsoft Excel.

2.2 Critical limits of Soil Micronutrients

Soil samples are classified into low, medium and high classes based on the critical levels of individual micronutrient (Sheoran *et al.*, 2018) ^[17] is mentioned in the Table1. The percentage size distribution of each class was also evaluated at three rice productivity regions.

Table 1: Critical limits of DTPA extractable Zn, Cu, Fe and Mn.

Micronutrient	Soil Fertility Class		
	Low	Medium	High
Cu	<0.2	0.2-0.4	>0.4
Mn	<2.5	2.5-3.5	>3.5
Fe	<4.5	4.5-9	>9
Zn	<0.6	0.6-1.2	>1.2

2.2 Nutrient Indexing

Nutrient indexing system developed by Parker *et al.* 1951 ^[9] (and refined by Kumar *et al.*, 2013; Amara *et al.*, 2017) ^[3, 1] was adopted in the present study, which helps in evaluating the micronutrient status in the three rice productivity soils of Mahabubnagar district (Sachan and Krishna, 2022; Sangeetha *et al.*, 2023) ^[13, 15]. The nutrient index (NI) is determined by assigning a weight to the quantity of soil samples that fall into low, medium, and high classes of a particular nutrient. Accordingly, samples with low fertility class are assigned a weight of 1, medium with 2 and high with 3.

Nutrient Index =
$$\frac{[(N_L*1) + (N_M*2) + (N_H*3)]}{N_T}$$

Where, N_L = Number of samples under low class of nutrient.
N_M = Number of samples falling under medium class of nutrient.

N_H = Number of samples falling under high class of nutrient.
N_T = Total number of samples analysed for a nutrient in the study area.

Separate indices are calculated for each available micronutrient Cu, Zn, Fe and Mn. The soils were rated as per the NI values as low (less than 1.66), medium (1.66-2.33) and high (more than 2.33) fertility class (Ramamurthy and Bajaj, 1969) ^[11].

3. Results and Discussion

3.1 Available Micronutrients

Crop yields and/or quality may be negatively impacted by imbalances in the plough layer, whether they are caused by an excess or a shortage of micronutrients. Therefore, maintaining appropriate micronutrient levels in the soil is crucial for both meeting plant needs for sustained agricultural output and preventing any possible buildup of particular nutrients. The results of the study area obtained from the laboratory analysis are analysed using descriptive statistics namely, mean, standard deviation, coefficient of variation and are outlined in Table 2. The percentage size distribution (PSD) of the soils for micronutrients in the study area, along with their significance values yielded on carrying out ANOVA are tabulated in the table 3 as Percent size distribution^(a) and One way ANOVA^(d) respectively.

Available Copper

The available Cu content in the study area ranged from 0.96 to 5.76 mg kg⁻¹ (mean 2.71 mg kg⁻¹) in HRS, 0.97 to 6.96 mg kg⁻¹ (mean 2.63 mg kg⁻¹) in MRS, and 0.18 to 7.92 mg kg⁻¹ (mean 2.59 mg kg⁻¹) in LRS. All the samples (100%) across the three productivity classes fall under high category, and align with the results of Sannidi *et al.* (2022) ^[16], inferring that Cu is abundant and non-limiting in all rice productivity classes.

Available Manganese

Available Mn varied between 4.04 and 32.99 mg kg⁻¹ (mean 12.22 mg kg⁻¹) in HPRS, 1.67 and 33.08 mg kg⁻¹ (mean 11.93 mg kg⁻¹) in MPRS, and 2.81 to 27.06 mg kg⁻¹ (mean 10.87 mg kg⁻¹) in LPRS. The PSD^(a) depicts that, the levels of Mn are high in HRS (100%). Whereas, 93% of soils in MRS and LRS are still Mn-sufficient, demonstrating an adequate Mn status, though little proportion of them fall into low to medium categories. In MRS and LRS soils, the trace amounts of low and medium Mn indicate localized variability rather than a general deficit.

Available Iron

Available Fe content ranged from 10.92 to 45.30 mg kg⁻¹ (mean 34.18 mg kg⁻¹) in HPRS, 10.87 to 43.50 mg kg⁻¹ (mean 33.61 mg kg⁻¹) in MPRS, and 8.61 to 41.01 mg kg⁻¹ (mean 32.71 mg kg⁻¹) in LPRS. The distribution of Mn-PSD^(a) demonstrates that, for all rice productivity classes, Fe is predominantly high. 100% of samples in HRS and MRS fall into the high category, signifying total sufficiency and lack of deficit. Only about 1.33% of samples in LRS fall into the medium group, while 98.67% of samples still remain high, indicating near- adequacy.

Available Zinc

The available Zn content ranged from 0.17 to 2.67 mg kg⁻¹ (mean 1.12 mg kg⁻¹) in HPRS, 0.17 to 2.33 mg kg⁻¹ (mean 1.05 mg kg⁻¹) in MPRS, and 0.18 to 1.73 mg kg⁻¹ (mean 0.86 mg kg⁻¹) in LPRS. A balanced but suboptimal availability status is revealed by the distribution of Zn-PSD^(a), with significant percentages of soils falling into the low and medium categories.

In HRS and MRS, Zn is found to be equally distributed among the low (30.67%), medium (30.67%), and high (38.67%) classes indicating moderate overall fertility with significant heterogeneity. In LRS, the distribution is relatively constrained. Most of the samples fall under medium (46.67%), followed by low (30.67%) with the least proportion (22.67%) in high class. From this, it can be understood that the situation is comparatively more restricted in LRS, indicating growing deficiency of Zn with decreasing productivity. The mean values of the above micronutrients were tested for their significance by one way ANOVA, across the three productivity classes (Table 3^(d)): Available Cu, Mn and Fe did not differ significantly, as indicated by non-significant *p* values (*p* > 0.05). In contrast, available Zn content showed a significant variation among productivity levels. The observed variation in Zn availability among productivity classes may be attributed to differences in soil organic carbon content, reduced micronutrient availability under higher soil pH conditions, and the precipitation of zinc as zinc sulphide under anaerobic conditions prevalent in rice-growing soils (Kumar *et al.*, 2020) ^[4]. Given that rice is highly sensitive to zinc deficiency, the availability of Zn plays a critical role in maintaining soil quality and significantly influences rice growth and productivity (Roy *et al.*, 2022) ^[12].

3.2 Nutrient Index (NI) and Fertility rating of rice soils

Soil nutrient index (NI) values developed for the study area are tabulated in the Table 3^(b). These NI values for the three rice productivity soils of Mahabubnagar district helps in understanding the fertility status of the soils (Table 3^(c)) for

available cationic micronutrients and can be interpreted as low (less than 1.66), medium (1.66-2.33) and high (more than 2.33) fertility classes (Ramamurthy and Bajaj, 1969) ^[11]. NI values for Available Cu are 3.00 in HRS and MRS; whereas 2.96 for LRS. NI values for Available Mn ranged from 3.00 in HRS, 2.89 MRS and 2.96 for LRS. NI values for Available Fe ranged from 3.00 in HRS and MRS; whereas 2.99 for LRS. NI values for Available Zn ranged from 2.08 in HRS and MRS and 1.92 for LRS. Figure 1 depicts the variation of NI values across the three rice productivity soils for the available micronutrients in soil. Thus, these NI values revealed that available Cu, Mn and Fe were in the high category across HRS, MRS and LPRS, indicating their sufficiency. In contrast, available Zn registered medium NI values, with comparatively lower index in LRS, suggesting zinc as a potential limiting micronutrient influencing rice productivity. These findings are inline with those of Mandavgade *et al.*, 2015 ^[7].

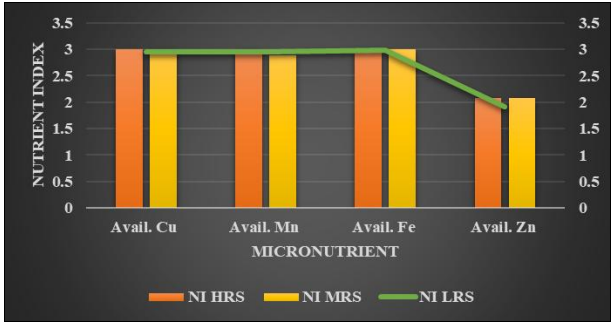


Fig 1: Trends of NI across HRS, MRS and LRS

Table 2: Available micronutrients status among the three productivity soils

Productivity Micronutrient	HRS				MRS				LRS			
	Minimum	Maximum	Mean ± SD	CV	Minimum	Maximum	Mean ± SD	CV	Minimum	Maximum	Mean ± SD	CV
Avail. Cu	0.96	5.76	2.71±1.20	44.22	0.97	6.96	2.63±1.13	43.02	0.18	7.92	2.59±1.18	45.43
Avail. Mn	4.04	32.99	12.22±6.29	51.48	1.61	33.08	11.93±6.64	55.69	2.81	27.06	10.87±6.19	56.91
Avail. Fe	10.92	45.30	34.18±7.10	20.78	10.87	43.50	33.61±5.71	17.00	8.61	41.01	32.71±7.14	21.84
Avail. Zn	0.17	2.67	1.12±0.70	62.75	0.17	2.33	1.05±0.61	58.30	0.18	1.73	0.86±0.40	46.20

Table 3: Percent size distribution^(a), NI^(b), Fertility rating^(c) and One way ANOVA^(d) of cationic micronutrients among the three rice productivity soils.

Micronutrient	Productivity	Percentage size distribution ^(a) (%)			Nutrient Index ^(b)	Fertility Rating ^(c)	p-value ^(d)
		Low	Medium	High			
Avail. Cu	HRS	0.00	0.00	100.00	3.00	High	0.83
	MRS	0.00	0.00	100.00	3.00	High	
	LRS	1.33	1.33	97.33	2.96	High	
Avail. Mn	HRS	0.00	0.00	100.00	3.00	High	0.39
	MRS	4.00	2.67	93.33	2.89	High	
	LRS	0.00	4.00	96.00	2.96	High	
Avail. Fe	HRS	0.00	0.00	100.00	3.00	High	0.40
	MRS	0.00	0.00	100.00	3.00	High	
	LRS	0.00	1.33	98.67	2.99	High	
Avail. Zn	HRS	30.67	30.67	38.67	2.08	Medium	0.02*
	MRS	30.67	30.67	38.67	2.08	Medium	
	LRS	30.67	46.67	22.67	1.92	Medium	

*Significant at 5% and 2%

4. Conclusion

Balanced soil micronutrient levels are essential for sustaining agro-ecosystems, ensuring efficient nutrient use, protecting the environment, and maintaining crop yield and quality by avoiding both deficiency and excess in the plough layer. The fertility status of rice soils in the Mahabubnagar state of Telangana revealed that Cu, Mn, and Fe were sufficient (high NI) across

HRS, MRS, and LPRS whereas Zn remained at a medium range, with a relatively lower index in LPRS, suggesting zinc as a potential limiting element for rice productivity. Therefore, soil-test based zinc fertilization, with minimal or no supplementation of Cu, Mn, and Fe especially in the low productivity soils in the study area helps in achieving the targeted yields. This practice of balanced fertilization in conjunction with integrated nutrient

management practices has the potential to enhance zinc availability and subsequently improve rice productivity in the region.

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References

- Amara DMK, Patil PL, Kamara AM, Saidu DH. Assessment of soil fertility status using nutrient index approach. *Acad J Agric Res*. 2017;5(2):28-38.
- Havlin HL, Beaton JD, Tisdale SL, Nelson WL. Soil fertility and fertilizers: an introduction to nutrient management. 7th ed. New Delhi (India): PHI Learning Pvt Ltd; 2010. p. 1-516.
- Kumar P, Kumar A, Dhyani BP, Kumar P, Shahi UP, Singh SP. Soil fertility status in some soils of Muzaffarnagar district of Uttar Pradesh, India, along with Ganga canal command area. *Afr J Agric Res*. 2013;8(14):1209-17.
- Kumar U, Mishra VN, Kumar N, Srivastava LK, Bajpai RK. Soil physical and chemical quality under long-term rice-based cropping system in hot humid eastern plateau of India. *Commun Soil Sci Plant Anal*. 2020;51(14):1930-45.
- Lindsay WL, Norvell WA. Development of a DTPA soil test for zinc, iron, manganese, and copper. *Soil Sci Soc Am J*. 1978;42(3):421-8.
- Malik RS, Yadav HK, Narender R, Sangwan PS. Background levels of zinc, iron, manganese and copper in soil series of Haryana and their relationship with soil properties. *Indian J Agric Sci*. 2017;87(8):110-38.
- Mandavgade RR, Waikar SL, Dhamak AL, Patil VD. Evaluation of micronutrient status of soils and their relation with some chemical properties of soils of northern tahsils (Jintur, Selu and Pathri) of Parbhani district. *J Agric Vet Sci*. 2015;8(2):38-41.
- Manivikas K, Hasan A, David AA, Thomas T, Reddy IS. Evaluation of soil nutrient index and physico-chemical parameters of soil from different blocks of Kurnool district, Andhra Pradesh, India. *Int J Plant Soil Sci*. 2022;34(20):125-33.
- Parker FW, Nelson WL, Winters E, Miles IE. The broad interpretation and application of soil test information. *Agron J*. 1951;43:105-12.
- Prasad LK, Bindu JP, Damodar DRE, Rao CC, Ravisankar H. Assessment of soil fertility under northern light soil area of FCV tobacco in Andhra Pradesh. *J AgriSearch*. 2021;8(2):95-8.
- Ramamoorthy B, Bajaj JC. Available nitrogen, phosphorus and potassium status of Indian soils. *Fertil News*. 1969;14:25-36.
- Roy D, Datta A, Jat HS, Choudhary M, Sharma PC, Singh PK, Jat ML. Impact of long-term conservation agriculture on soil quality under cereal based systems of North West India. *Geoderma*. 2022;405:115391.
- Sachan HK, Krishna D. Assessment of soil fertility status using nutrient index approach in cassava farms of Rewa province, Fiji. *Indian J Agric Res*. 2022;56(5):594-8.
- Sagwal A, Wadhwa P, Kaushal S. Essentiality of micronutrients in soil: a review. *Int J Plant Soil Sci*. 2023;35(24):56-65.
- Sangeetha M, Kumaraperumal R, Prabhu PC, Vijayakumar M, Suganya S, Parasuraman P, Rani MA. Evaluation of soil nutrient status of Regional Research Station farm, Paiyur, Krishnagiri district, Tamil Nadu, India. *Int J Plant Soil Sci*. 2023;35(23):67-73.
- Sannidi S, Bindu GM, Neelima TL, Umadevi M. Soil quality mapping in the groundnut belt of erstwhile Mahabubnagar district, Telangana, India using GIS. *Curr Sci*. 2022;122(6):600-8.
- Sheoran HS, Phogat VK, Dahiya R, Dhull S, Kakar R. Comparative effect of organic and conventional farming practices on micronutrient content in different textured soils of Haryana, India. *Int J Curr Microbiol Appl Sci*. 2018;7(4):3399-407.
- Government of India. Unified Portal for Agricultural Statistics: state-wise APY report. New Delhi: Government of India; 2025. <https://upag.gov.in/dash-reports/statewiseapy>
- Yunas M, Ahmed S, Majeed T, Ahmad B, Rahim M, Rizvi SA, *et al*. Micronutrient indexing of soils located in Attock district of Pakistan: a guide to replenish the nutrient deficiency. *J Appl Res Plant Sci*. 2023;4(2):642-6.