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Iranna Pattar
District Programme Officer, BAIF Institute for Sustainable Livelihoods and Development, Karnataka, India

Sagar Kadao
Thematic Programme Executive, BAIF Institute for Sustainable Livelihoods and Development, Pune, Maharashtra, India

Sagar Jadhav
Senior Research Officer, BAIF Development Research Foundation, Pune, Maharashtra, India

Mukul Baviskar
Additional Chief Programme Executive, BAIF Institute for Sustainable Livelihoods and Development, Maharashtra, India

Sujata Kangude
Thematic Programme Executive, BAIF Institute for Sustainable Livelihoods and Development, Pune, Maharashtra, India

Corresponding Author:
Sagar Jadhav
Senior Research Officer, BAIF Development Research Foundation, Pune, Maharashtra, India

Assessment of fertility status of soils in Hunsur block of Mysuru district, Karnataka

Iranna Pattar, Sagar Kadao, Sagar Jadhav, Mukul Baviskar and Sujata Kangude

Abstract
Soil available Macro and micronutrient deficiency due to exhaustive cultivation is an emerging threat to modern agriculture. Delineating the distribution of micronutrients is an effective strategy for sustainable agriculture. A current study was performed to investigate the nutrient distribution of soils from the Hunsur block of Mysuru district, Karnataka. A total 110 soil samples were collected from the farmer's field of Rangaiahnakoppalu, Cholenahalli, Kempanahalli, Gerasanahalli, Mydanahalli, Ayarahalli and Harohalli villages. The soil samples were analyzed for the physico-chemical properties (pH, Electrical conductivity and organic carbon), Available primary nutrients (Nitrogen, Phosphorous and Potassium) and available micronutrients (Iron, Manganese, Copper and Zinc) content in the soil. The data revealed that the 110 analyzed soil samples were moderately acidic to neutral in soil pH with normal electrical conductivity and low in organic carbon. Analysis of available primary nutrients revealed the low in available nitrogen, low to very high in available phosphorous and potassium. Further, analysis of available micronutrients showed that the all samples had deficient to excess in available iron, excess in manganese with few exceptions, sufficient to excess in copper and sufficient in zinc. The trend of various available macro and micro nutrient suggest imbalance of nutrient availability in soil which need immediate attenuation for managing soils on sustainable basis.

Keywords: Chemical properties, macronutrients, micronutrients, Hunsur, Mysuru, Karnataka

1. Introduction
Karnataka state encompasses a diverse range of geological, climatic, and physiographic features that have played a significant role in soil formation, resulting in the development of various soil types. These soils possess distinct morphological and physicochemical properties that directly impact plant growth and influence the cropping patterns, thereby giving the state a unique agricultural status. The Mysuru district is situated on the undulating table land of the southern Deccan plateau, within the watershed of the Kaveri River. This river flows through the northwestern and eastern parts of Mysuru. The district is divided into seven blocks, with Hunsur block having a larger agricultural land area that is cultivated multiple times. This can be attributed to the availability of irrigation facilities. Following Hunsur, the Periapatna block ranks second in terms of area sown more than once, followed by KR Nagar and Nanjangud. The district is characterized by the presence of different soil types, including red soil, lateritic soil, deep black soil, saline alluvial-colluvial soil, and brown forest soil. Additionally, the district is rich in various minerals such as sillimanite, kyanite, quartz, chromite, soapstone, felsite, magnesite, corundum, limestone, dolomite, graphite, siliconite, and dunite (Prasanna Kumar, 2021) [22].

Having technical knowledge about the soils is essential for understanding the local ecology and planning effective cropping systems. Soil fertility plays a crucial role in determining crop yields. Therefore, assessing the fertility status of soils in a particular area or region is of utmost importance for sustainable agricultural production. Unfortunately, the intensive use of chemical fertilizers, coupled with imbalanced and insufficient fertilizer application, has led to a significant decline in their efficiency in recent years (Meena *et al.*, 2006) [14].

The physio-chemical properties of soil, such as pH, electrical conductivity, organic carbon, and calcium carbonates, play a crucial role in determining the availability of essential nutrients in the soil. Proper management of these properties can enhance the supply of essential nutrients from the soil. The nourishment of crops in any given area largely depends on the availability of soil nutrients and their profile similarities.

These challenges necessitate a close analysis of the physico-chemical and chemical status of soils, especially when managing them for the benefit of individual farmers. To address this, a soil survey was conducted, providing a comprehensive account of the soil's anatomy and physiology. This survey not only helps in selecting the appropriate fertilizers and dosages but also keeps farmers informed about the inherent qualities and nutrient deficiencies in the soil. However, due to intensive cultivation practices and imbalanced use of chemical fertilizers, the fertility and productivity of the soil are declining. Therefore, an assessment of the fertility status of soils in the Hunsur block of Mysuru district, Karnataka, was undertaken.

Fig 1: Location map of study area

Material and Methods

1. Location

The Hunsur block of Mysuru district covers an area of 981 square kilometers. Geographically, the Hunsur block is situated between north latitude 12023'56.36" to 12010'52.27" and east longitudes between 76029'42.92" to 7609'25.83". Climatologically, the Hunsur block falls under a semi-arid climate. The surveyed soil area falls within the southern dry agro-climatic zone of Karnataka state. The average annual rainfall in the Hunsur block is 816 mm. Forests covered 7.92 percent of the total geographical area. It has been observed that 52.54 percent of the area is under cultivation, with 30.86 percent of the total geographical area of the Hunsur block being sown more than once. The remaining area, consists of which is not available for cultivation, other uncultivable lands and fallow lands, covering 20.12 percent, 3.41 percent and 15.98 percent respectively of the total geographical area. In Agriculture paddy, maize, ragi and vegetables are the major crops cultivated in the Kharif season whereas, maize, vegetables and oilseeds are major crops cultivated in Rabi season. Tobacco and paddy are water intensive crops grown in Hunsur block (Anonymus, 2023) [2].

2. Study Details

A total of 110 surface soil samples were collected from various farmers' fields in Rangaiahnakoppalu, Cholenahalli, Kempanahalli, Gerasanahalli, Mydanahalli, Ayarahalli, and Harohalli villages of Hunsur block, Mysuru, Karnataka. These samples were collected from the plow layer (0-15 cm depth) and were then air-dried and sieved through a 2 mm sieve. The physico-chemical and fertility parameters of the soil were analyzed. The pH and electrical conductivity (EC) of the soils were determined using the standard procedures described by Jackson (1973) [9]. The organic carbon (OC) content of the soil samples was determined using the Walkley and Black method (Nelson and Sommers, 1996) [16]. The available nitrogen (N) content in the soil was estimated using the modified alkaline permanganate method (Sahrawat and Burford, 1982) [25]. For acidic soils, the available phosphorous (P_2O_5) content was determined using the Brays No. 1 method outlined by Bray and Kurtz (1945) [4], while for neutral to alkaline soils, Olsen's method (Olsen and Sommers, 1982) [17] was used. The available potassium (K_2O) content was determined using the neutral normal ammonium acetate method given by Helmke and Sparks (1996) [16]. The available micronutrients (Iron, Zinc, Copper, and Manganese) were extracted using the DTPA extraction method and determined using an Atomic Absorption Spectrophotometer (Lindsay and Norvell, 1978) [13]. The organic carbon content, available nitrogen, available phosphorous, and available potassium content in the soil were categorized as low, medium, or high. The available micronutrient content in the soil was categorized as deficient, sufficient, or in excess.

Results and Discussion

Physico-chemical properties of the soil

The physico-chemical properties of the 110 soil samples collected from the Hunsur block of Mysuru district were analyzed. The data obtained are presented in Table 1 and will be discussed in the following sections.

Table 1: Ranges and means of physico-chemical properties of the soils

Sr. No.	Villages	pH	EC (dS m^{-1})	OC (%)
1	Rangaiahnakoppalu	5.24-7.09 (6.02)	0.08-0.21 (0.13)	0.12-0.50 (0.34)
2	Cholenahalli	5.28-7.01 (5.86)	0.09-0.15 (0.12)	0.21-0.47 (0.37)
3	Kempanahalli	5.84-6.72 (6.24)	0.10-0.12 (0.11)	0.26-0.42 (0.34)
4	Gerasanahalli	5.26-7.08 (6.08)	0.10-0.17 (0.13)	0.12-0.50 (0.34)
5	Mydanahalli	5.46-7.04 (6.23)	0.10-0.20 (0.13)	0.21-0.47 (0.35)
6	Ayarahalli	5.58-6.91 (6.20)	0.09-0.18 (0.12)	0.12-0.54 (0.38)
7	Harohalli	5.92-6.22 (6.07)	0.13-0.16 (0.15)	0.29-0.33 (0.31)
Ranges and means of 110 soil samples		5.24 - 7.09	0.08-0.21	0.12-0.54
		6.08	0.13	0.35

Soil reaction (pH)

The pH of 110 soil samples was analyzed, and the results ranged from 5.24 to 7.09, with a mean value of 6.08 (Table 1). It was observed that the village Rangaiahnakoppalu had the highest soil pH of 7.09, while the lowest soil pH (5.24) was found in the same village. The soil samples collected from Cholenahalli village had the lowest mean soil pH (5.86), whereas the soil samples from Kempanahalli village had the highest mean soil pH (6.24).

Table 2: Soil reaction (pH)

pH (Ratings)	Range	No. of samples	Samples (%)
Extremely acidic	< 4.0		
Strongly acidic	4.1-5.0		
Moderately acidic	5.1-6.0	54	49.1
Slightly acidic	6.1-6.5	32	29.1
Neutral	6.6-7.5	24	21.8
Slightly alkaline	7.6-8.0		
Moderately alkaline	8.1-9.0		
Strongly alkaline	9.1-10.0		
Very strongly alkaline	>10.1		

Table 2 presents the data on soil pH ratings according to Banger and Zende (1978) [3]. Out of the 110 soil samples, 54 (49.1%) were moderately acidic (pH 5.1-6.0), 32 (29.1%) samples were slightly acidic (pH 6.1-6.5), and 24 (21.8%) samples were neutral (pH 6.6-7.5). In general, most of the soil samples exhibited a moderately acidic in reaction.

Gurumurthy and Sridhara (2012) [6] found that the soils in the Hunsur block ranged from moderately acidic to neutral (pH 5.2 to 7.5) in terms of soil reaction. The soils were slightly acidic in reaction (Table 1). This could be attributed to acidic parent material such as granitic gneiss (Anathanarayana and Perur, 1973) [1]. Generally, the soils in the western ghat and coastal Karnataka regions are acidic in reaction due to heavy rainfall and subsequent leaching of bases. The acidity in the study area is further exacerbated by the application of acidic fertilizers and the lack of inputs to neutralize the soil acidity (Kavitha and Sujatha, 2015) [11].

Electrical conductivity (EC)

The electrical conductivity of the soil was also analyzed, and the results are presented in Table 1. The electrical conductivity of the 110 soil samples ranged from 0.08 to 0.21 dSm^{-1}, with a mean value of 0.13 dSm^{-1}. The lowest electrical conductivity of soil (0.08 dSm^{-1}) was found in the Rangaiahnakoppalu village, while the highest electrical conductivity of soil (0.21 dSm^{-1}) was also found in the Rangaiahnakoppalu village. The lowest mean soil electrical conductivity of soil (0.11 dSm^{-1}) was found in the soil samples collected from Kempanahalli and the soil samples of Harohalli had the highest (0.15 dSm^{-1}) mean.

Table 3: Electrical conductivity

EC (dSm^{-1})		No. of samples	Samples (%)
Class	Range		
Normal	< 0.8	110	100
Critical for salt sensitive crops	0.8-1.6		
Critical for salt tolerant crops	1.6-2.5		
Injurious to all crops	> 2.5		

The data presented in Table 3, shows the classification of soil electrical conductivity ratings according to Jackson (1967) and Richards (1954). Among the 110 soil samples analyzed, all of them fell under the normal class (<0.8 dSm^{-1}) of electrical conductivity.

The results indicate that the soils in the Hunsur block of Mysuru district, Karnataka have low electrical conductivity, suggesting a non-saline nature. This can be attributed to the leaching of soluble salts by irrigation water and high rainfall. The conditions of study areas were not favorable for the accumulation of salts through externally added fertilizers, as reported by Roy and Landey (1962) [24] and Gurumurthy and Sridhara (2012) [6].

Organic carbon (OC)

Regarding organic carbon, Table 1 provides the analytical data on soil organic carbon content. The study found that the organic carbon content ranged from 0.12 to 0.54 percent, with a mean of 0.35 percent. The lowest organic carbon content (0.12 %) was observed in the soil samples from Rangaiahnakoppalu, Gerasanahalli, and Ayarahalli, while the highest (0.54 %) was found in the soil sample of Ayarahalli. The mean organic carbon content was lowest (0.31 %) in the soils of Harohalli and highest (0.38 %) in the soil samples of Ayarahalli.

Table 4: Organic carbon

OC (%)		No. of samples	Samples (%)
Class	Range		
Low	<0.5	108	98.2
Medium	0.5-0.75	2	1.8
High	>0.75		

Table 4 presents the data on soil organic carbon rating according to Banger and Zende (1978) [3]. Out of the 110 soil samples analyzed, the majority (108) had low (> 0.5 %) organic carbon, while two samples had medium (0.5-0.75 %) organic carbon. The low organic carbon content in these soils can be attributed to the degradation of organic matter at a faster rate, coupled with little or no addition of organic manures and low vegetative cover on the fields. Intensive cropping is also a contributing factor to the low organic carbon content. Similar results were also reported by Prabhavati *et al.* (2015) [21] for the soils of the northern dry zone of Karnataka.

Status of available primary nutrients *viz.*, nitrogen, phosphorous and potassium in soil

The soil samples collected from various villages in the Hunsur block of Mysuru district, Karnataka were examined to determine the status of available primary nutrients, namely nitrogen (N), phosphorous (P_2O_5), and potassium (K_2O). The analytical data for these primary nutrients are presented in Table 5, which shows the range and mean values.

Table 5: Ranges and means of primary nutrients in soil

Sr. No.	Villages	Avail. N (Kg ha^{-1})	Avail. P_2O_5 (Kg ha^{-1})	Avail. K_2O (Kg ha^{-1})
1	Rangaiahnakoppalu	87.8-143.0 (127.7)	10-64 (36.2)	81.5-407.5 (225.6)
2	Cholenahalli	92.2-142.4 (123.6)	12-64 (31.3)	92.0-329.5 (186.0)
3	Kempanahalli	123.6-130.5 (127.3)	28-44 (36.7)	114.0-132.0 (123.2)
4	Gerasanahalli	85.3-140.5 (123.3)	10-68 (37.6)	79.0-407.5 (321.6)
5	Mydanahalli	89.7-139.9 (123.2)	16-68 (41.6)	117.5-406.0 (301.3)
6	Ayarahalli	85.3-140.5 (121.2)	8-64 (32.3)	93.5-406.0 (274.5)
7	Harohalli	133.6-136.7 (135.2)	10-28 (19.0)	225.0-329.5 (277.3)
Ranges and means of 110 soil samples		85.3-143.0	8-68	79-407.50
		124.5	35.9	262.11

Available Nitrogen

The data pertaining to the nitrogen content in the soil is presented in Table 5. The nitrogen levels in the soil range from 85.3 to 143.0 Kg ha^{-1}, with an average value of 124.5 Kg ha^{-1}. The soil samples from Gerasanahalli and Ayarahalli villages exhibited the lowest nitrogen content in the soil (85.3 Kg ha^{-1}). Conversely, the soil samples from Rangaiahnakoppalu village displayed the highest nitrogen content in soil (143.0 Kg ha^{-1}). In terms of the mean nitrogen content in soil, Ayarahalli had the lowest value (121.2 Kg ha^{-1}), while Harohalli had the highest value (135.2 Kg ha^{-1}).

Table 6: Available Nitrogen

Available Nitrogen (Kg ha^{-1})		No. of samples	Samples (%)
Class	Range		
Low	<280	110	100
Medium	280-560	-	-
High	>560	-	-

In Table 6, it can be observed that all the soil samples exhibited low nitrogen content in the soil. This could potentially be attributed to the low organic matter content in these areas, which is a result of the high temperatures facilitating the rapid degradation and removal of organic matter, leading to nitrogen deficiency. Gurumurthy and Sridhara (2012) [6] conducted a study on the potassium status and physico-chemical properties of FCV tobacco-growing soils in the southern transition zone of Karnataka. They found that the soils in the Hunsur block ranged from low to medium in terms of available nitrogen content. Similarly, the soils in Belthur and Kallahalli were also classified as low in available nitrogen, which aligns with our study area. Krishnamurthy *et al.* (1988) [12] also reported similar findings.

Available phosphorus

Moving on to available phosphorus, the data in Table 5, reveals that the phosphorus content in the soil ranged from 8 to 68 Kg ha^{-1}, with an average value of 35.9 Kg ha^{-1}. The soil samples from Ayarahalli had the lowest soil phosphorus content (8 Kg ha^{-1}). On the other hand, the soil samples from Gerasanahalli and Mydanahalli exhibited the highest phosphorus content in the soil (68 Kg ha^{-1}). In terms of the mean phosphorus content, Harohalli had the lowest value of 19.0 Kg ha^{-1}, while Mydanahalli had the highest value of 41.6 Kg ha^{-1}.

Table 7: Available P_2O_5

Available P_2O_5 (Kg ha^{-1})		No. of samples	Samples (%)
Class	Range		
Low	< 22.5	29	26.4
Medium	22.5-55	65	59.1
High	> 55	16	14.5

The available phosphorus data indicates a range of low to high status, as shown in Table 7. Out of the 110 analyzed soil samples, 29 percent were found to have low phosphorus levels. This could be attributed to the higher removal of phosphorus compared to replenishment and fixation, particularly in laterite soils rich in hydrated and amorphous oxides of iron and aluminum (Mini, 2003) [15]. Sathisha and Badrinath (1994) [26] also reported low phosphorus levels in the Western Ghats. Among the soil samples analyzed, 65 (59.1 %) had medium phosphorus content in certain areas of the study where the pH was moderately acidic. The near-neutral pH plays a significant role in enhancing phosphorus availability. The increase in pH may lead to an increase in available phosphorus due to the reduced activities of iron and aluminum, resulting in higher solubility of strengite and variscite and increased electro-negativity of colloidal complexes, leading to a decrease in phosphorus sorption (Dhanya *et al.*, 2009) [5]. On the other hand, 16 (14.5 %) soil samples had high phosphorus levels, possibly due to different management practices followed by farmers. The continuous application of phosphatic fertilizers to crops like tobacco and maize, along with low utilization rates (30-40 Kg ha^{-1}), may contribute to the high buildup of phosphorus (Shetty *et al.*, 2008) [27]. Vasuki *et al.* (1998) [28] also noted the occurrence of high phosphorus buildup in these soils.

Available potassium

Regarding available potassium, the analytical data provided in Table 5, shows a range of 79.0 to 407.5 Kg ha^{-1}, with a mean value of 262.1 Kg ha^{-1}. The lowest available potassium content (79.0 Kg ha^{-1}) was found in the soil samples from Gerasanahalli, while the highest (407.5 Kg ha^{-1}) was observed in the soil samples from Rangaiahnakoppalu and Gerasanahalli. The mean available potassium content in the soil was lowest (123.2 Kg ha^{-1}) in the soil samples from Kempanahalli and highest (321.6 Kg ha^{-1}) in the soil samples from Gerasanahalli.

Table 8: Available K_2O

Available K_2O (Kg ha^{-1})		No. of samples	Samples (%)
Class	Range		
Low	< 140	21	19.1
Medium	140-330	53	48.2
High	> 330	36	32.7

Table 8 presents the rating data for available potassium content in soil as suggested by Patil *et al.* (2017a). Among the soil samples analyzed, 21 (19.1 %) were low, 53 (48.2 %) were medium, and 36 (32.7 %) were high in available potassium content in soil. This range of available potassium in the soils of Southern Karnataka was also observed by

Jagadesh (2004) [10]. The relatively medium to higher contents of available potassium in some soils could be attributed to higher amounts of potassium-bearing minerals in the soils. Additionally, it is reported that surface soils in Karnataka had higher concentrations of water-soluble and exchangeable potassium (Patil *et al.*, 2011).

Status of available micronutrients in the soil

Moving on to the status of available micronutrients in the soil, Table 9 presents the ranges and means of DTPA extractable micronutrients, including iron, manganese, zinc, and copper in the soil samples collected from different villages of Hunsur block of Mysuru district in Karnataka state.

Table 9: Ranges and means of available micronutrients in the soil

Sr. No.	Villages	Iron (mg Kg^{-1})	Manganese (mg Kg^{-1})	Zinc (mg Kg^{-1})	Copper (mg Kg^{-1})
1	Rangaiahnakoppalu	2.24-9.72 (6.28)	4.19-9.77 (7.31)	1.63-2.69 (2.12)	1.32-3.73 (2.43)
2	Cholenahalli	0.86-5.70 (3.88)	1.55-9.77 (7.33)	1.02-2.81 (1.89)	1.05-3.94 (2.32)
3	Kempanahalli	2.39-4.50 (3.38)	8.17-10.31 (9.15)	1.70-1.84 (1.75)	2.10-2.76 (2.54)
4	Gerasanahalli	0.45-5.63 (2.10)	1.54-11.25 (5.89)	0.89-2.01 (1.38)	0.45-2.65 (1.32)
5	Mydanahalli	0.79-5.34 (2.45)	2.56-17.36 (8.57)	0.89-2.31 (1.44)	0.65-2.04 (1.35)
6	Ayarahalli	0.87-6.38 (2.82)	1.54-17.21 (8.38)	0.78-1.98 (1.42)	0.56-2.06 (1.77)
7	Harohalli	1.23-1.78 (1.51)	10.79-16.35 (13.57)	1.01-1.08 (1.05)	1.33-1.54 (1.44)
Ranges and means of 110 soil samples		0.45-9.72	1.54-17.36	0.78-2.81	0.45-3.94
		3.60	7.52	1.66	1.76

Available Iron (Fe)

The iron content data is provided in Table 9, where the available iron in the 110 soil samples ranged from 0.45 to 9.72 mg Kg^{-1} of soil, with an average value of 3.60 mg Kg^{-1}. The soil samples from Gerasanahalli had the lowest available iron content in soil (0.45 mg Kg^{-1}), while the soil sample from Rangaiahnakoppalu had the highest available iron content (9.72 mg Kg^{-1}). The lowest mean available iron content in soil (1.51 mg Kg^{-1}) was found in the soil samples from Harohalli, whereas the highest mean (6.28 mg Kg^{-1}) was observed in the soil samples from Rangaiahnakoppalu.

Table 10: Available Iron

Iron (mg Kg^{-1})		No. of samples	Samples (%)
Class	Range		
Deficient	< 2.5	40	36.4
Sufficient	2.5-4.5	33	30.0
Excess	> 4.5	37	33.6

The ratings for available iron content in the soil, as suggested by Patil *et al.* (2017b) [18], are presented in Table 10. Out of the 110 soil samples analyzed, 40 samples fell into the low class with iron content below 2.5 mg Kg^{-1}, 33 samples belonged to the sufficient class with iron content ranging from 2.5 to 4.5 mg Kg^{-1}, and 37 samples were classified as excess with iron content above 4.5 mg Kg^{-1}. The high iron content may be attributed to low soil pH. However, the presence of 40 percent of soil samples in the iron deficient class could be due to the high accumulation of phosphorus in the soil resulting from the continuous application of phosphatic fertilizers for crops such as tobacco and maize over an extended period, coupled with their low utilization of 30-40 kg ha^{-1} (Shetty *et al.*, 2008) [27]. Phosphorus binds with iron to form iron phosphate, thereby reducing the availability of iron in the soil.

Available Manganese (Mn)

Moving on to available manganese, the data is provided in Table 11. The available manganese in the 110 soil samples analyzed ranged from 1.54 to 17.36 mg Kg^{-1} of soil, with an average value of 7.52 mg Kg^{-1}. The soil samples from Ayarahalli and Gerasanahalli had the lowest available manganese content in the soil (1.54 mg Kg^{-1}). On the other hand, the soil sample from Mydanahalli exhibited the highest available manganese content in the soil (17.36 mg Kg^{-1}). The lowest mean available manganese content (5.89 mg Kg^{-1}) was found in the soil samples from Gerasanahalli, while the highest mean value (13.57 mg Kg^{-1}) was in the soil samples of Harohalli.

Table 11: Available Manganese

Mn (mg Kg^{-1})		No. of samples	Samples (%)
Class	Range		
Deficient	<2.0	4	3.6
Sufficient	2.0-4.0	7	6.4
Excess	> 4.0	99	90.0

The data for the ratings of available manganese, as suggested by Patil *et al.* (2017b) [18], can be found in Table 11. Among the 110 soil samples that were analyzed, 99 samples were classified as excess (> 4.0 mg kg^{-1}), 7 samples fell into the sufficient range (2.0 to 4.0 mg Kg^{-1}), and only 4 samples were categorized as deficient (< 2.0 mg Kg^{-1}) in terms of available manganese content in the soil.

Available zinc (Zn)

Regarding available zinc (Zn), the analytical data is provided in Table 9. The available zinc content in the 110 soil samples ranged from 0.78 to 2.81 mg Kg^{-1}, with an average value of 1.66 mg Kg^{-1}. The soil samples from Ayarahalli exhibited the lowest available zinc content in soil (0.78 mg Kg^{-1}), while the soil sample from Cholenahalli had the highest available zinc content in soil (2.81 mg Kg^{-1}). In terms of the mean available zinc content in soil, the soil samples from Harohalli had the lowest value (1.05 mg Kg^{-1}), whereas the soil samples from Rangaiahnakoppalu had the highest mean value (2.12 mg Kg^{-1}).

Table 12: Available Zinc

Zn (mg Kg^{-1})		No. of samples	Samples (%)
Class	Range		
Deficient	<0.6	0	0
Sufficient	0.6-1.5	44	40
Excess	> 1.5	66	60

The data for the ratings of available zinc, as suggested by Patil *et al.* (2017b) [18], can be found in Table 12. Among the 110 soil samples that were analyzed, 44 samples (40.0 %) belonged to the sufficient class (0.6 to 1.5 mg Kg^{-1}) and 66 samples belonged to the excess class (> 1.5 mg Kg^{-1}) in terms of available zinc. It is worth noting that most of the soil samples fell into the excess class, which could be attributed to the presence of zinc as a contaminant in phosphatic fertilizers. The continuous addition of chemical fertilizers may have contributed to the increased levels of zinc in these soils. These findings align with those of Kavitha and Sujatha (2015) [11], who also observed adequate zinc content in the soils of Kerala.

Available Copper (Cu)

Regarding available copper (Cu), the analytical data can be found in Table 9. The available copper content in the 110 analyzed soil samples ranged from 0.45 to 3.94 mg Kg^{-1}, with a mean value of 1.76 mg Kg^{-1}. The soil sample from Gerasanahalli had the lowest available copper content (0.45 mg Kg^{-1}), while the soil sample from Cholenahalli had the highest (3.94 mg Kg^{-1}). In terms of mean values, the soil sample from Gerasanahalli had the lowest mean of available copper content (1.32 mg Kg^{-1}), while the soil samples from Kempanahalli had the highest mean of available copper content (2.54 mg Kg^{-1}).

Table 13: Available copper

Cu (mg Kg^{-1})		No. of samples	Samples (%)
Class	Range		
Deficient	<0.2	0	0
Sufficient	0.2-5.0	110	100
Excess	> 5.0	0	0

The ratings of available copper, as suggested by Patil *et al.* (2017b) [18], can be found in Table 13. All 110 soil samples analyzed belonged to the sufficient class, with copper levels ranging from > 0.2 to 5.0 mg kg^{-1}. The study area predominantly consists of acidic soil, and as the soil pH decreases, the adsorption of copper to permanent charges decreases as well. This phenomenon is common and results in higher availability of copper to crops. Additionally, the frequent application of fungicides containing copper to both soil and crops may have contributed to increased copper levels in the soils (Patil *et al.*, 2017b) [18].

Conclusion

In conclusion, the investigation conducted in the Hunsur block of Mysuru district in Karnataka state revealed that the soils were moderately acidic to neutral in soil reaction, with normal electrical conductivity and low organic carbon content. Analysis of available primary nutrients showed low levels of nitrogen and varying levels of phosphorous and potassium (ranging from low to high). Furthermore, analysis of micronutrients indicated that all soil samples were deficient to excess in available iron, excess in manganese (with a few exceptions), sufficient to excess in copper, and sufficient in zinc. The study suggests intensive soil nutrient mining because of the overuse of soils. Lower content of important parameters like organic carbon impacting the soil health and sustainability of agriculture may become serious in the coming future. The sample study of one block can be representative of a state where similar situations may exist that need immediate attention for sustainable management of soil resources.

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