RESEARCH ARTICLE

AVAILABLE MICRONUTRIENTS IN SOILS OF CHIKKARSINKERE HOBLI OF MADDUR TALUK, MANDYA DISTRICT OF KARNATAKA

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Abstract: Available micronutrients and their relationship with different soil properties was studied in four hundred soil samples collected from different locations of 42 villages representing the soils of Chikkarsinkere hobli of Maddur Taluk Mandya district of Karnataka. The soils were analysed for textural separates, physico-chemical properties and status of available micronutrients. On the basis of pH and EC values, these soils are moderately acidic to very strongly alkaline (5.6 to 9.4). Majority of the soils under study area were found deficient in available zinc. Available iron, copper and manganese were sufficient to adequate. The availability of micronutrients in soils significantly influenced by soil properties viz, textural separates, organic carbon, $CaCO_3$, CEC and pH of soils. Available Zn ranged between 0.02 to 6.36 mg kg^{-1} with a mean value of 0.63 mg kg^{-1}, available Fe ranged ranged from 0.14 to 95.4 mg kg^{-1} with a mean value of 25.29 mg kg^{-1}. Available Cu ranged between 0.14 to 6.10 mg kg^{-1} with a mean value of 1.29 mg kg^{-1}. Available Mn ranged between 1.20 to 40.20 mg kg^{-1} with a mean value of 13.41 mg kg^{-1}. Organic carbon, clay, and CEC were positively correlated with available Zn, Fe, Cu and Mn while pH, $CaCO_3$ and sand were negatively correlated.

Keywords: Available micronutrients, Fertility, Correlation, Critical limit

INTRODUCTION

The productivity of soil mainly depends upon its ability to supply nutrients to the growing plants. The crop productivity can be increased by utilizing the available basic information related to soil analysis, use of agro-ecosystem and management practices of soil. The optimum plant growth and crop yield depends not only on the total amounts present in the soil at a particular time but also on their availability which in turn is controlled by physical and chemical properties of soil. The physico-chemical properties of the soil like mechanical composition, pH, EC, OC and $CaCO_3$ etc. influence the availability of micronutrients which in turn affect the crop yield. Among the micronutrients the deficiency of zinc is wide spread in Indian soils followed by boron in eastern part of country. Calcareous and saline sodic soils are mostly found deficient in iron, manganese and copper. Sakal and Singh (2001) reported that 47 per cent Indian soils were deficient in available zinc. The optimum plant growth and crop yield depends not only on the total amount of nutrients present in the soil at a particular time but also on their availability.

Micronutrients are important for maintaining soil health and also increasing productivity of crops (Ratan *et al*. 2009). The soil must supply micronutrients for desired growth of plants. Increased removal of micronutrients as a consequence of adoption of high yielding varieties (HYVs) and intensive cropping together with shift towards high analysis NPK fertilizers has caused decline in the level of micronutrients in the soil. The improper nutrient management has led to emergence of multinutrient deficiencies in the Indian soils (Sharma 2008). Keeping in view the close relationship between soil properties and available zinc and iron, the present study was undertaken to analysis the influence of soil properties on the availability of zinc and iron for better land use management of soils of Chikkarsinkere Hobli of Maddur Taluk, Mandya district of Karnataka as information available on these soil is rather scanty.

MATERIAL AND METHOD

Location and extent: Chikarsinekere Hobli is situated in Maddur taluk of Mandya district in Karnataka State (Fig. 1), which falls in the southern dry zone. It lies between 76° 58′ to 77° 05′E longitude and 12° 26′ to 12° 34′ N Latitude, and covered by 57 D/14, 57 D/15, 57 H/2 & 57 H/3 Survey of India toposheets. Total area of the hobli is 16,873 ha. Major part of the area (7,478) is under canal irrigation and rainfed area occupies about 4,367 ha. Major part of the Hobli is under Cauvery canal irrigation.

Climate: The Chikkarasinakere hobli enjoys sub-tropical monsoonic climate. The average temperature of the area ranges between 16^0 and 35^0 C. The normal rainfall received in the area is about 770 mm. Out of this, about 50 per cent is received during southwest monsoon, 20 per cent during northeast monsoon and 30 per cent during the summer period.

Geology: Granites and gneiss, commonly known as peninsular gnesis, are the major rock types of the

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hobli. They are the oldest rock formations of the world and belong to the Archean period.

Landforms: The Chikkarsinkere hobli forms part of Bangalore plateau. The elevation ranges from 600 m near Shimsha River to 769 m. The major landforms identified in the area are uplands, lowlands and valleys. The uplands are characterized by nearly level to very gently sloping summits, followed by gently to very gently sloping side slopes, which merges with nearly level lowlands/valleys. The uplands occupy about 55 per cent of the area in the hobli. The lowlands occur mostly below the tanks or between the uplands and valleys. They have flat topography and mostly cultivated to paddy or sugarcane. The valleys and lowlands together occupy about 29 per cent of the area in the hobli.

Natural vegetation: Chikkarsinkere hobli has a number of tree species, shrubs and herbs. The natural vegetation of the area consists of tropical dry deciduos types. Tamarind, Ficus, Mango, Uluchemira, Babul, Acacia, Bage etc. are dominantly found in the area.

Present land use: Out of the total area of 16,873 ha, about 12,739 ha area is under cultivation, which is more than 75 per cent of the total area available in the hobli. Major part of the cultivable lands (7478 ha) are under canal irrigation. The canal irrigated lands are used for the cultivation of rice, sugarcane, coconut, mulberry etc, and rainfed areas are used for the cultivation of ragi, pulses and oilseeds. Vegetables crops like tomato, brinjal, chillies and cucumber are grown in a small area, mostly for local consumption in the area.

Soil sampling: Four hundred representative composite soil samples from a depth of 0-15 cm were collected with the help of a wooden *Khurpi*. Samples were completely air-dried and passed through 2 mm sieve and stored in properly labeled plastic bags for analysis.

Soil analysis: Soil pH was measured in 1:2.5 soil water suspension using glass electrode pH meter. Electrical conductivity was measured in 1:2.5 soil water supernatant solution with the help of conductivity bridge (Jackson 1973). The organic carbon was determined by rapid titration method (Walkley and Black 1934) and $CaCO_3$ by rapid titration method (Puri 1930). The available micronutrients in soil samples were extracted with DTPA (0.005 M DTPA + 0.01 M $CaCl_2$ + 0.1 M TEA, pH 7.3) as per the method described by Lindsay and Norvell (1978) and the concentration of Zn, Fe, Cu and Mn in the DTPA-extract was determined using atomic absorption spectrophotometer.

RESULT AND DISCUSSION

Physico-chemical Properties

The data presented (Table 1) on soil properties showed that the sand content ranged between 25.5 to 89.7 per cent with a mean value of 56.9 per cent, silt content varied from 1.1 to 21.6 per cent with a mean value of 8.1 per cent and clay content varied from 8.1 to 59.9 per cent with a mean value of 35.1 per cent. The soils are moderately acidic to very strongly alkaline (5.6 to 9.4). The alkaline nature of soil under study is attributed to the fairly optimum base saturation in the region (Sharma *et al.* 1992). The electrical conductivity (EC) ranged from 0.02 to 0.62 dSm^{-1} with a mean value of 0.17 dSm^{-1}. All of the soil samples are under < 1 dSm^{-1}. It indicates that they are non saline in nature as suggested by Muhr *et al.* (1963) comparatively low content of soluble salts appear to be due to the type of climate of the area which is fairly sufficient to leach out major part of soluble salts from the soil. The organic carbon ranged from 0.07 to 13.7 g kg^{-1} soil with a mean value of 3.17 g kg^{-1} soil. It showed a considerable variation with types and topography of soil. Relatively higher values of organic carbon can be ascribed to annual addition of plant residues and also the application of FYM (Ashok, 1998). The $CaCO_3$ ranged from 0 to 50.0 g kg^{-1} with a mean value of 18.5 g kg^{-1} is a useful parameter to assess the extent of nutrient availability and their release behaviour. The CEC values ranged from 0.57 to 57.4 cmol (p^+) kg^{-1} with a mean value of 16.17 cmol (p^+) kg^{-1}.

Available Zinc

DTPA-zinc ranged between 0.02 to 6.36 mg kg^{-1} with a mean value of 0.63 mg kg^{-1}. It was observed that zinc was most deficient in Chikkarsinkere hobli (Fig. 2). The DTPA-Zn consistently decreased with increasing depth of soil profile (Naik 2014). Clay and silt are the most active fractions of soil. Most of the zinc bearing minerals such as biotite, hornblende, augite and others are easily weathered and thus released zinc is subjected to secondary soil forming processes such as adsorption of Zn^{2+} ions by clay. Zinc (Zn^{2+}) ions adsorbed on soil complexes may easily be removed by leaching especially in sandy loam soils and adsorbed zinc is in equilibrium with the soil solution zinc. The amount of extracted zinc is likely to increase with the increase in fineness of the soil texture. It has also been reported that organic matter plays an important role in controlling availability of zinc particularly in alkaline soils (Das, 2000). A close examination of the data in Table 2 indicates significant increase in zinc content with increase in organic carbon (r = 0.360*). The availability of zinc increased significantly with increase in organic carbon because zinc forms soluble complexes (Chelates) with soil organic matter component. On the other hand, the availability of zinc reduced significantly with an increase in $CaCO_3$ (r = - 0.201**) and pH (r = - 0.347*) of soil. At high pH and $CaCO_3$ content, zinc forms insoluble compounds such as $Zn(OH)_2$ and $ZnCO_3$ which can reduce the availability of zinc. There was inverse relationship between zinc and pH as the pH increases the availability of zinc decreased. The findings of the present investigation are confirmed by the results of Singh (2006) and Mehra (2007).

Available Iron

The data presented in Table 1 showed that DTPA-iron ranged from 0.14 to 95.4 mg kg^{-1} with a mean value of 25.29 mg kg^{-1}. The available iron significantly increased with increase in clay (r = 0.375*), organic carbon (r = 0.344*), and CEC (r = 0.439*). On the other hand the availability of iron was reduced significantly with an increase in $CaCO_3$ (r = -0.378*) and pH (r = -0.414*). Further, the availability of iron was non-significantly affected by the other characteristics of soils. It was significantly increased with increase in finer fractions (silt and clay) because these fractions are helpful improving the soil structure and aeration of soils. The available iron was found to increase with increase in CEC of soils due to more availability of exchange sites on soil colloids. The availability of iron enhanced significantly with increase in organic matter because (i) organic matter is helpful in improving soil structure and aeration conditions, (ii) organic matter protect the oxidation and precipitation of iron into unavailable forms and (iii) supply of chelating agents, which increase the solubility of iron compounds. On the other hands, its availability was found to be reduced with increase in pH_2 and $CaCO_3$ contents of soils. Most readily available form of iron is Fe^{2+} ions, which convert into less soluble form (Fe^{3+} ions) after oxidation. High pH is responsible for its oxidation. Hence, the availability of iron reduced at higher pH level. Beside this, at high pH iron is also precipitated as insoluble $Fe(OH)_3$ which reduces its availability. The $CaCO_3$ present in soils gets converted into bicarbonates ions which reduces the availability of iron and the chlorosis caused in these conditions is known as a "lime induced chlorosis". The availability of iron at high pH is reduced due to the reduction in its solubility. The solubility of iron decreased with increase in pH is due to the formation of insoluble iron hydroxide and carbonates. Similar results were reported by Gupta (2003) and Yadav and Meena (2009).

Available copper

The data presented in Table 1 showed that DTPA-copper varied from 0.14 to 6.10 mg kg^{-1} with a mean value of 1.29 mg kg^{-1}. As given in Table 2 the available copper significantly increased with increase in clay (r = 0.421*) and organic carbon (r = 0.252**). On the other hand the availability of copper was reduced significantly with an increase in $CaCO_3$ (r = -0.275*) and pH (r = -0.204**). The organic acid molecules present in organic matter solubilise Cu^{2+} ions by chelation and complexion and as a result of this organic binding, there is more dissolved copper in the soil solution than normally occurs in the absence of organic matter. Furthermore the availability of copper enhanced with increase in silt and clay contents and this might be due to the improvement of soil structure and aeration conditions of soils with increase in finer fractions in soil mass. The availability of copper suppresses significantly with sand contents because the coarseness of soil texture reduces the adsorption of Cu^{2+} ions on exchange sites. The availability of copper reduces at high pH and high $CaCO_3$ content due to the formation of less soluble compounds like $Cu(OH)_2$ and $CuCO_3$. Similar results were reported by Singh *et al.*, (2013).

Available Manganese

The data presented in Table.1 showed that DTPA-manganese varied from 1.20 to 40.20 mg kg^{-1} with a mean value of 13.41 mg kg^{-1}. A close examination of data in Table 2 indicates that the availability of manganese in these soils enhanced with increase in clay (r = 0.593*), organic carbon (r = 0.228*), and CEC (r = 0.194). There was a positive correlation between manganese and organic carbon as the organic carbon content increases the availability of manganese increases. The increase in availability of manganese with increase in clay and silt might be due to the improvement in soil structure and aeration conditions. On the other hand the availability of manganese was reduced significantly with an increase in $CaCO_3$ (r = -0.313*), sand (r = -0.121) and pH (r = -0.233**). The availability of Mn decrease with increase in $CaCO_3$ content and pH of soils might due to the formation of less soluble compounds like $MnCO_3$ or $Mn(OH)_2$. The higher pH favours the formation of less soluble organic complexes of Mn, which reduces the availability of Mn and the activity of soil micro-organism which oxidizes soluble Mn^{2+} (Singh *et al.*, 2013).

Table 1. Ranges and mean values of physico-chemical properties of soils of Chikkarsinkere Hobli.

Ranges	Soil properties											
	Sand (%)	Silt (%)	Clay (%)	pH	EC (dSm^{-1})	OC g kg^{-1}	$CaCO_3$ g kg^{-1}	CEC cmol (p+) kg^{-1}	Micronutrients (mg kg^{-1})			
									Zn	Fe	Cu	Mn
Maximum	89.7	21.6	59.9	9.4	0.62	13.7	50.0	57.4	6.36	95.4	6.10	40.20
Minimum	25.5	1.1	8.1	5.6	0.02	0.07	0.0	0.57	0.02	0.14	0.14	1.20
Mean	56.9	8.1	35.1	7.9	0.17	3.17	18.5	16.26	0.63	25.29	1.29	13.41

Table 2. Correlations between soil properties and available micronutrients of soils of Chikkarsinkere Hobli.

Micronutrients	Soil properties							
	Sand (%)	Silt (%)	Clay (%)	pH	EC (dSm^{-1})	OC g kg^{-1}	$CaCO_3$ g kg^{-1}	CEC cmol (p+) kg^{-1}
Zn	-0.258*	0.191	0.413*	-0.347*	0.413*	0.360*	-0.201**	0.265*
Fe	-0.131	0.251**	0.375*	-0.414*	0.168	0.344*	-0.378*	0.439*
Cu	-0.289*	0.316*	0.421*	-0.204**	0.042	0.252**	-0.275*	0.226**
Mn	-0.121	0.136	0.593*	-0.233**	0.148	0.228**	-0.313*	0.194

Level of significance at .05% (**) and .01 % (*)

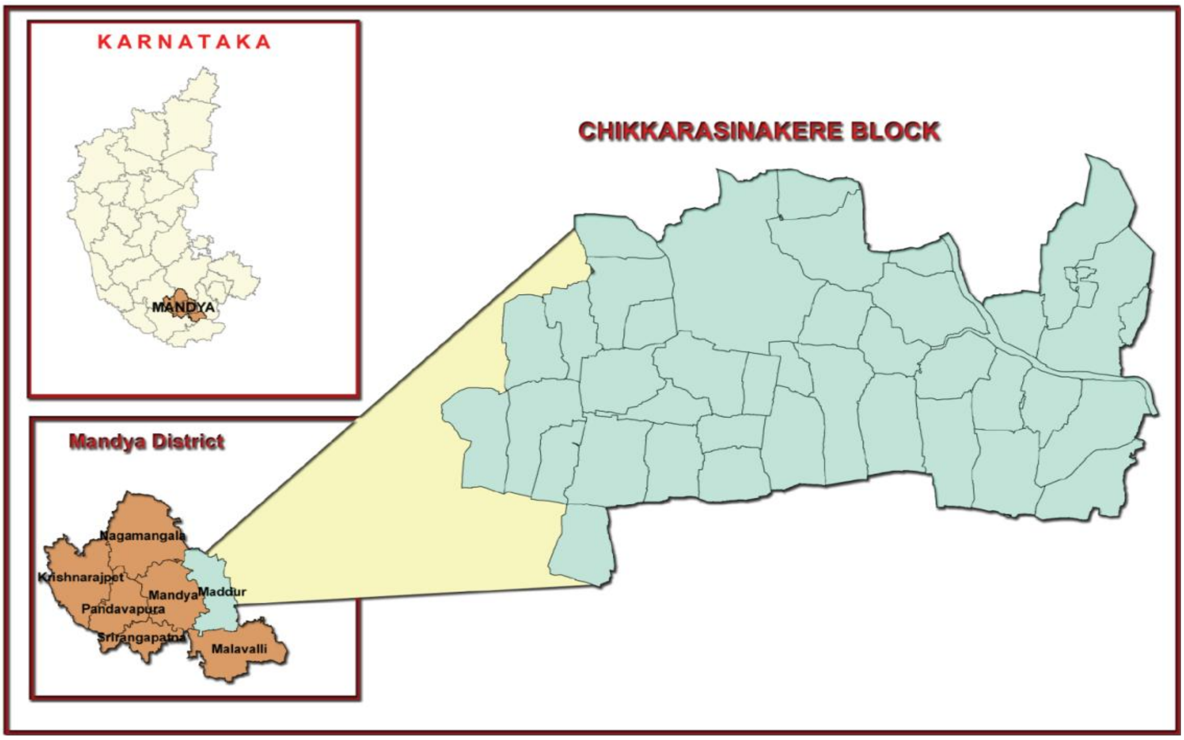

Fig. 1. Location map of Chikkarsinakere Hobli in Mandya district

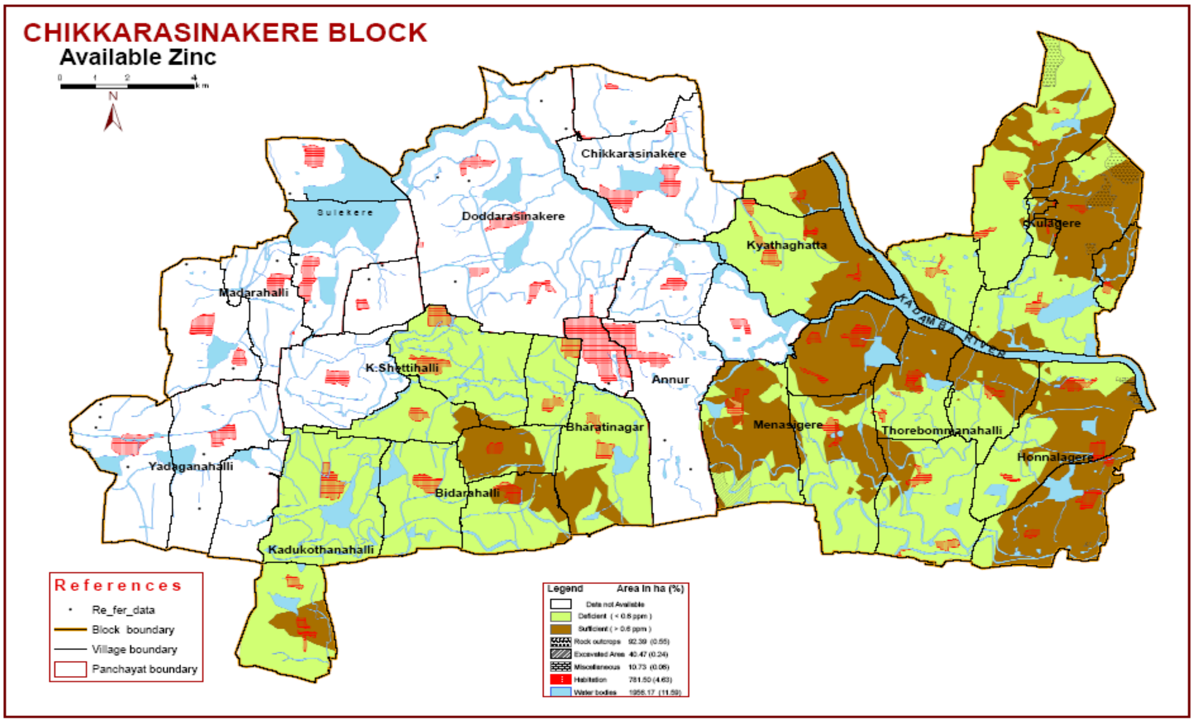

Fig. 2. Available Zinc status in Chikkarasinkere hobli

CONCLUSION

From the study it can be concluded that the availability of micronutrients in soils significantly influenced by soil properties viz. textural separates, organic carbon, $CaCO_3$, CEC and pH of soils. The DTPA-Zn consistently decreased with increasing depth of soil profile. The available iron significantly increased with increase in clay. Majority of the soils under study area were found deficient in available zinc. Available iron, copper and manganese were sufficient to adequate. One can also state that, judicious application of chemical fertilizers may help to maintain soil quality and productivity.

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