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Distribution of Micronutrients in Soil of Garhi Tehsil, Banswara District of Rajasthan, India

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A B S T R A C T

Distribution of available micronutrients and their relationship with different soil properties was studied in one hundred soil samples collected from different locations of 25 villages representing the soils of Garhi Tehsil of Banswara district, Rajasthan. The soils were analysed for textural separates, physico-chemical properties and status of available micronutrients. Texture of soils varied from sandy clay loamy to clay loam. On the basis of pH and EC values, these soils were found neutral to moderately alkaline and non-saline in nature. Majority of the soils under study area were found deficient in available zinc followed by iron, sufficient to adequate in available copper and manganese. The availability of micronutrients in soils significantly influenced by soil properties viz. textural separates, organic carbon, $CaCO_3$, CEC and pH of soils. Available zinc ranged between 0.22 and 1.16 mg kg^{-1} with a mean value of 0.63 mg kg^{-1}, available iron ranged from 2.23 to 27.64 mg kg^{-1} with a mean value of 7.75 mg kg^{-1}. Available copper ranged between 0.42 and 1.9 mg kg^{-1} with a mean value of 0.79 mg kg^{-1}. Available manganese ranged between 2.10 and 17.6 mg kg^{-1} with a mean value of 7.42 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.

Introduction

Production and productivity of many crops is declined due to decline in soil fertility status, imbalanced fertilizer use, and lack of knowledge on micro fertilizers. Efficiency of major nutrients is increased in presence of micronutrients (Mehta 1974). There exists a narrow gap between the deficiency and toxicity level. 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, iron, copper and manganese. The present study was undertaken to analysis the influence of soil properties on the availability of zinc, iron, copper and manganese for better land use management in soils of Garhi tehsil, Banswara district (Zone IV-b) of Rajasthan as information available on these soil is rather scanty.

Materials and Methods

Garhi Tehsil comprising a part of Agro-climatic Zone (IV-b) of Rajasthan. Geographical location of Garhi Tehsil is 23^0 35' 21" N latitudes and 74^0 09' 01" E longitudes with an area of 706.75 km^2. It is situated in Banswara district. The climate of Garhi Tehsil is semi-arid characterized by extremes of temperature and low wind velocity. During the summers, the temperature of Garhi remains quite high, like in any other parts of Banswara district. The temperature however varies between 25°C to 45°C in summer months.

The annual rainfall in Garhi Tehsil of Banswara district is about 972 mm. One hundred representative composite soil samples from a depth of 0-15 cm were collected with the help of a wooden *Khurpi*. The air dry soil samples passed through 2 mm sieve were analyzed for mechanical composition by International pipette method (Richards, 1954), Soil pH was measured in 1:2 soil water suspension using glass electrode pH meter.

Electrical conductivity was measured in 1:2 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), calcium carbonate by rapid titration method (Piper, 1950) and CEC was determined by leaching the soil with 1 N NH_4OAC and subsequent displacement of the adsorbed NH_4^+ following the methods of Schollenberger and Simon (1945).

Micronutrients in soils were extracted by DTPA-extract (0.005 M diethylene triamine penta acetic acid and 0.01 M $CaCl_2$ + 0.1 N triethanaloamine at pH 7.3) method (Lindsay and Norvel, 1978) and the concentration was measured in Atomic Adsorption Spectrophotometer.

Results and Discussion

Physico-chemical properties

The results (Table 1) on soil properties showed that the sand content ranged between 15.34 to 77.1 per cent with a mean value of 38.54 per cent, silt content varied from 10.0 to 46.23 per cent with a mean value of 31.60 per cent and clay content varied from 7.09 to 55.68 per cent with a mean value of 29.97 per cent. The soils are neutral to moderately alkaline (7.02 to 8.05). 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 0.40 to 0.79 dSm^{-1} with a mean value of 0.57 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 (sub-humid) of the area which is fairly sufficient to leach out major part of soluble salts from the soil.

The organic carbon ranged from 4.18 to 8.92 g kg^{-1} soil with a mean value of 6.10 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. The $CaCO_3$ ranged from 11.00 to 71.00 g kg^{-1} with a mean value of 29.44 g kg^{-1} is a useful parameter to assess the extent of nutrient availability and their release behavior. The CEC values ranged from 6.00 to 34.90 cmol (p^+) kg^{-1} with a mean value of 17.57 cmol (p^+) kg^{-1}.

Table.1 Ranges and mean values of physico-chemical properties of soils of Garhi Tehsil.

Ranges	Soil properties											
	Sand (%)	Silt (%)	Clay (%)	pH	EC (dSm^{-1})	OC $g\ k^{-1}$	$CaCO_3$ $g\ k^{-1}$	CEC cmol (p+) kg^{-1}	Micronutrients			
									Zn	Fe	Cu	Mn
									mg k^{-1}			
Maximum	77.1	46.23	55.68	8.05	0.79	8.92	71.00	34.90	1.16	27.64	1.90	17.60
Minimum	15.34	10.00	7.09	7.02	0.40	4.18	11.00	6.00	0.22	2.23	0.42	2.10
Mean	38.54	31.60	29.97	7.54	0.57	6.10	29.44	17.57	0.63	7.75	0.79	7.42

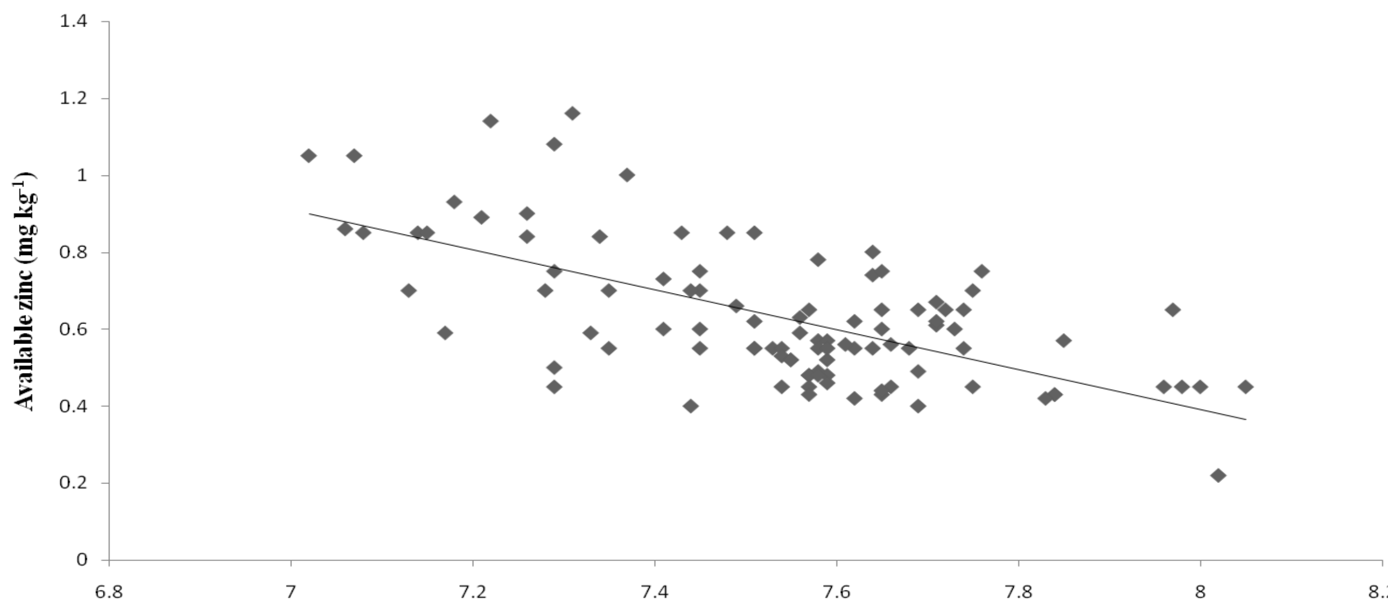

Fig. 1 Relationship between available zinc and pH in soils of Garhi Tehsil

Table.2 Correlations between soil properties and available micronutrients of soils of Garhi Tehsil

Micronutrients	Soil properties							
	Sand (%)	Silt (%)	Clay (%)	pH	EC (dSm^{-1})	OC $g\ k^{-1}$	$CaCO_3 g\ k^{-1}$	CEC cmol (p+) kg^{-1}
Zn	-0.055	0.018	0.124	-0.640**	-0.033	0.869**	-0.531**	0.102
Fe	-0.141	0.018	0.232*	-0.300**	0.036	0.684**	-0.416**	0.219*
Cu	0.086	-0.086	0.214*	-0.271**	-0.051	0.560**	-0.259**	0.164
Mn	-0.183	0.094	0.214*	-0.575**	-0.045	0.951**	-0.472**	0.152

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

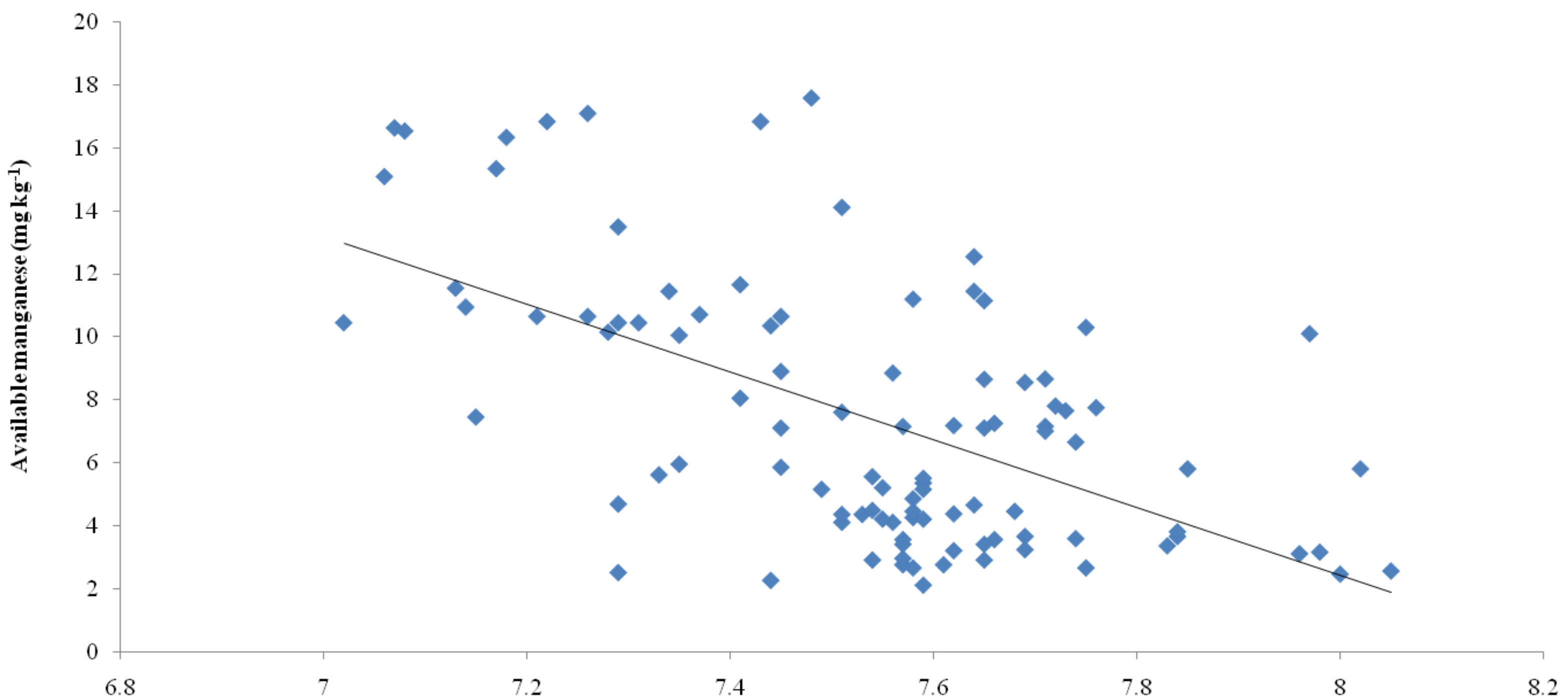

Fig. 2 Relationship between available manganese and pH in soils of Garhi Tehsil

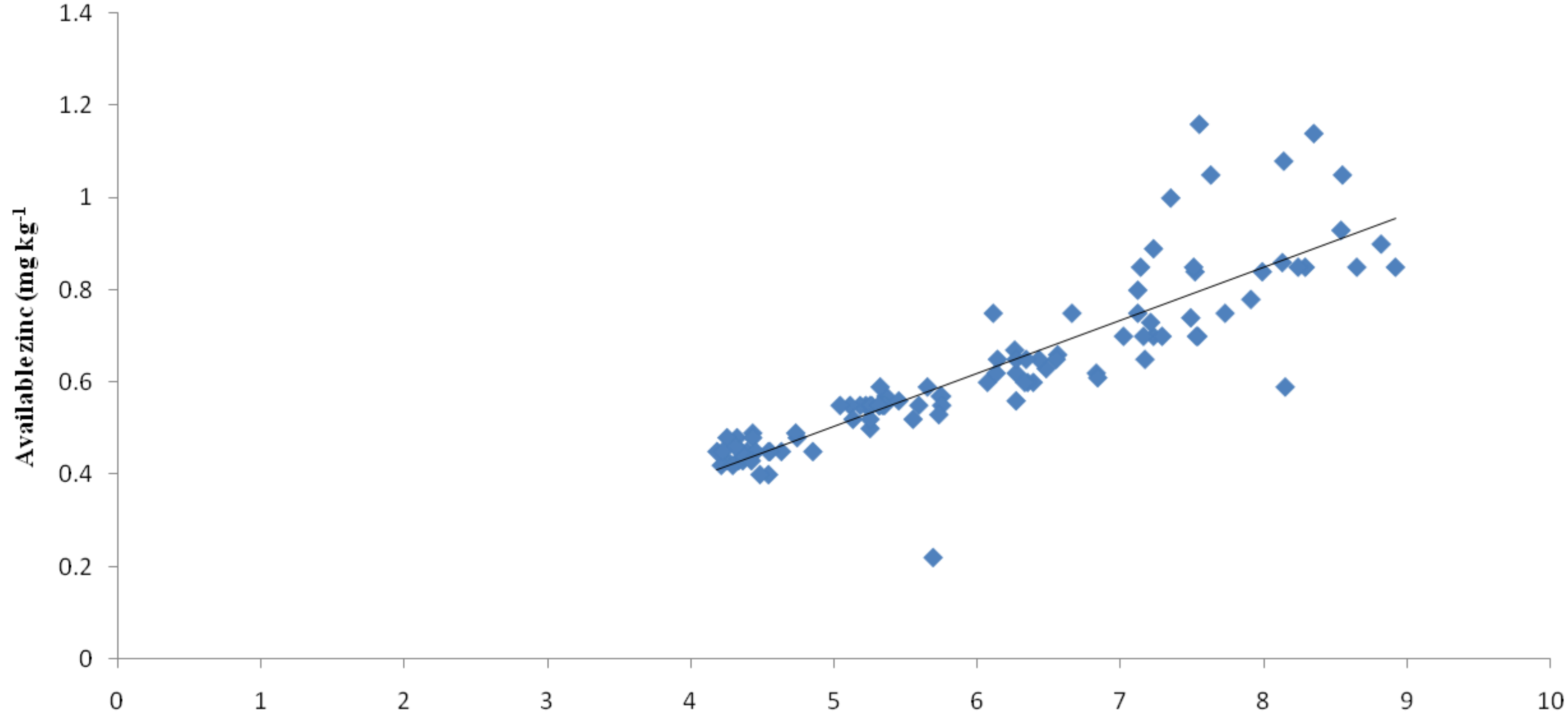

Fig. 3 Relationship between available zinc and organic carbon in soils of Garhi Tehsil

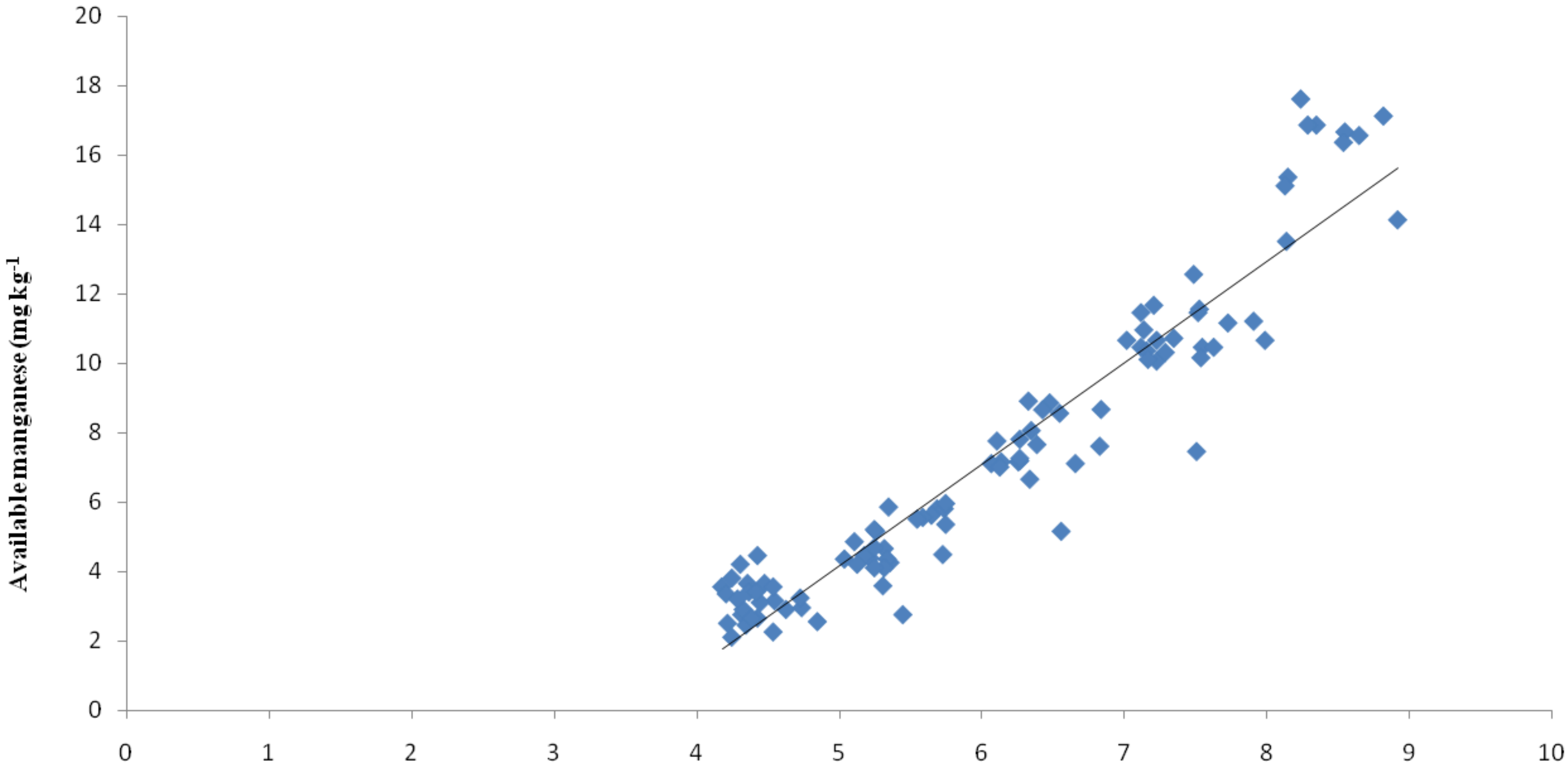

Fig. 4 Relationship between available manganese and organic carbon of soils of Garhi Tehsil

Available Zinc

DTPA-zinc ranged between 0.22 to 1.16 mg kg^{-1} with a mean value of 0.63 mg kg^{-1}. A close examination of the data (Table 2) indicates significant increase in zinc content with increase in organic carbon (r = 0.869**). The availability of zinc increased significantly with increase in organic carbon (Fig. 3) 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 = - 0.531**) and pH (r = - 0.640**) of soil. There was inverse relationship between zinc and pH (Fig. 1) as the pH increases the availability of zinc decreased (Singh 2006 and Mehra, 2007).

Available Iron

DTPA-iron ranged from 2.23 to 27.64 mg kg^{-1} with a mean value of 7.75 mg kg^{-1}. The available iron significantly increased with increase in clay (r = 0.232*), organic carbon (r = 0.684**), and CEC (r = 0.219*). On the other hand the availability of iron was reduced significantly with an increase in $CaCO_3$ (r = -0.416**) and pH (r = -0.300**). 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 (Gupta 2003, Yadav and Meena 2009).

Available copper

DTPA-copper varied from 0.42 to 1.90 mg kg^{-1} with a mean value of 0.79 mg kg^{-1}. Available copper significantly increased with increase in clay (r = 0.214*) and organic carbon (r = 0.560**). On the other hand the availability of copper was reduced significantly with an increase in $CaCO_3$ (r = -0.259**) and pH (r = -0.271**). 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 $CuCO_3$ (Singh *et al.,* 2013).

Available Manganese

DTPA-manganese varied from 2.10 to 17.60 mg kg^{-1} with a mean value of 7.42 mg kg^{-1}. A close examination of data (Table 2) indicates that the availability of manganese in these soils enhanced with increase in clay (r = 0.214*), organic carbon (r = 0.951**), and CEC (r = 0.152). There was a positive correlation between manganese and organic carbon (Fig. 4) 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 = -0.472**), sand (r = -0.183) and pH (r = -0.575**). The availability of Mn decrease with increase in $CaCO_3$ content and pH (Fig. 2) 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).

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