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Status of available micronutrients in soils of Neem Ka Thana tehsil, Sikar district of Rajasthan

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ABSRACT

The study was conducted to evaluate available micronutrients (Fe, Zn, Cu and Mn) status and their relationship with some of the soil properties. In general, textural class of soils was found to be in the category of sandy loam, sandy clay loam, loamy sand and loam.The pH of soils varied from 7.3 to 8.9, EC varied from 0.03 to 1.11 dSm^{-1} with a mean value of 0.14 dSm^{-1}, Organic carbon varied from 0.02 to 1.05 g kg^{-1} with a mean value of 0.37 g kg^{-1}, $CaCO_3$ ranged from 0.77 to 17.43 g kg^{-1} with a mean value of 4.20 g kg^{-1}. DTPA- Zn, Fe, Cu and Mn ranged from 0.02 to 1.84 mg kg^{-1}(mean 0.39 mg kg^{-1}), 2.20 to 12.86 mg kg^{-1}(mean 4.87mg kg^{-1}), 0.15 to 9.68 mg $kg^{-}1$(0.89 mg kg^{-1}) and 3.38 to 14.70 mg kg^{-1}(8.89 mg kg^{-1}), respectively. The available micronutrients had positive and significantly relationship with silt, clay, and organic carbon of soils whereas, negative one with sand, calcium carbonate and pH of the soils. The deficiencies of Zn, Fe and Cu in these soils were 92, 49 and 14 % respectivelywhereas available Mn was found adequate in all the soils.

Key words: Physico-chemical characteristics, micronutrients, Sikar

INTRODUCTION

Micronutrients are important for maintaining soil health and also increasing productivity of crops (Rattan *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). The information on availability of micronutrients of the study area is scanty and mainly based on the widely scattered sampling that is hardly sufficient to bring the variability in the soils of the area. Keeping this in view, the present investigation was carried out to know the distribution of DTPA-Zn, Fe, Cu and Mn and their relationship with soil properties in Neem Ka Thana tehsil.

MATERIAL AND METHODS

The soil survey was carried out in 194 villages of Neem Ka Thana tehsil. Soil samples were collected, air dried and passed through 2 mm sieve and analyzed for particle-size distribution following International Pipette method, pH and electrical conductivity in 1:2.5, Soil:water suspension(Jackson 1973). Organic carbon and calcium carbonate were estimated by standard procedures. The 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. The relationship between soil characteristics and micronutrients in soils was determind using correlation coefficient.

RESULTS AND DISCUSSION

Physico-chemical properties

The soils varied in texture from loamy sand to loam. The soils were neutral to moderately alkaline (7.3 to 8.9) in reaction. The alkaline nature of soil under study is attributed to the fairly optimum base saturation in the region. The electrical conductivity ranged from 0.03 to 1.11 dSm^{-1} with a mean value of 0.14 dSm^{-1}. Except one soil sample 66 soil samples are under < 1 dSm^{-1}indicating non-saline in nature. The organic carbon ranged from 0.02 to 1.05 g kg^{-1} with a mean value of 0.37 g kg^{-1}soil. Most of

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the soil samples were low in organic carbon.The $CaCO_3$ ranged from 0.77 to 17.43 g kg^{-1} with a mean value of 4.20 g kg^{-1}. The soils are noncalcareous (< 5 g kg^{-1}) to slightly calcareous (5-15 g kg^{-1}). The variation in calcium carbonate content may be attributed due to the difference in the type of parent material from which these soils have been formed.

Available zinc

Available zinc in soils ranged between 0.02 and 1.84 mg kg^{-1} with a mean value of 0.39 mg kg^{-1} (Table 1).Srivastava *et al.* (2016) presented the similar results. On the basis of critical limit (0.6 mg kg^{-1}) 92 % soil samples were deficient (<0.6 mg kg^{-1}) 5% soil samples were marginal (0.6 to 1.2 mg kg^{-1}) and 3% soil samples were adequate (<1.2kg-1) in available zinc. It has been reported that organic matter plays an important role in controlling availability of zinc particularly in alkaline soils. 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 = -0.227) and pH (r = -0.388) 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. Singh *et al.,* (2003) and Kumar *et al.,* (2011) reported similar results.

Table 1: Physico-chemical properties and status of available micronutrient in soils of Neem Ka Thana tehsil

Soil Characteristics	Range	Mean	Deficiency (%)
Physico-chemical properties			
Sand (%)	37.15 - 90.49	69.22	
Silt (%)	1.02 - 48.79	17.85	
Clay (%)	5.37 - 27.46	12.93	
pH	7.3 – 8.9		
EC (dSm^{-1})	0.03 – 1.11	0.14	
Organic carbon (g k^{-1})	0.02 – 1.05	0.37	
$CaCO_3$ (g k^{-1})	0.77 – 17.43	4,20	
Micronutrients			
Zinc (mg k^{-1})	0.02 – 1.84	0.39	92 %
Iron (mg k^{-1})	2.2 – 12.86	4.87	49 %
Copper (mg k^{-1})	0.15 -9.68	0.89	14
Manganese (mg k^{-1})	3.38 – 14.7	8.89	-

Available iron

Available iron content of soils ranged from 2.20 to 12.86 mg kg^{-1} with a mean value of 4.87 mg kg^{-1} (Table 1). Srivastava *et al.* (2016) also presented the similar results. Considering 4.5 as the critical limit 49% soil samples were deficient (< 4.5 mg kg^{-1}), 38% soil samples were marginal (4.5-7.5 mg kg^{-1}) and 13% soil samples fall in the category of adequate (> 7.5 mg kg^{-1}). The available iron significantly increased with increase in organic carbon and had positive correlation with OC (r = 0.226). Organic matter compounds are able to form Fe chelates that improve iron availability. Availability of iron was reduced with an increase in $CaCO_3$ (r = -0.054). The similar results were also reported by Singh *et al.,* (2003) and Kumar *et al.,* (2011). 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 bicarbonate ions which reduces the availability of iron.

Available copper

Available copper content in soils varied from 0.15 to 9.68 mg kg^{-1} with a mean value of 0.89 mg kg^{-1} (Table 1).Srivastava *et al.,* (2016) reported the similar results. Considering 0.2 mg kg^{-1} soil as a critical limit 14.9 % soil samples were deficient (<0.2 mg kg-1), 34.3 % soil samples were marginal (0.2-0.4 mg kg-1) and 50.7 % soil samples were adequate in available Cu. The available copper increased with increase in organic carbon (r = 0.015). The presence of organic matter promotes the

availability of copper and this could be ascribed as one of the reasons of the relationship between two. A positive correlation between these two indicates that higher copper in surface soil is due to higher organic carbon content at the surface. The availability of copper was decreased significantly with an increase in pH (r = -0.155) and calcium carbonate (r=-0.235). Similar findings were also reported by Kumar *et al.,* (2011). The organic acid molecules present in organic matter solubilize Cu^{2+} ions by chelation and complexion and as a result of the organic binding. The availability of copper decreases 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).

Table 2: Correlation coefficient between soil properties and available micronutrient in soils of Neem Ka Thana tehsil

Soil properties	Zinc	Iron	Copper	Manganese
Sand	0.011	-0.108	-0.274	-0.511
Silt	0.031	0.167	0.351	0.450
Clay	-0.104	-0.098	-0.080	0.327
pH	-0.388	-0.360	-0.155	-0.296
EC	0.628	0.043	0.040	0.060
Organic carbon	0.002	0.226	0.015	0.306
Calcium carbonate	-0.227	-0.054	-0.235	-0.205

Available manganese

Available manganese varied from 3.38 to 14.7 mg kg^{-1} with a mean value of 8.89 mg kg^{-1} (Table 1). Singh and Yadav (2017)also reported similar results. Considering the critical limit (> 4 mg kg^{-1}) the entire soil sample were adequate in available manganese. The availability of manganese in these soils enhanced with increase in clay (r = 0.327), organic carbon (r = 0.306). DTPA-extractable Mn was positively and significantly correlated with organic carbon. The increase in availability of manganese with increase in clay and silt might be due to the improvement in soil structure and aeration conditions. The availability of manganese was decreased significantly with an increase in $CaCO_3$ (r = -0.205). Verma *et al.,* (2005) and Kumar *et al.,* (2011) also reported similar results. The availability of Mn decreasedwith increase in $CaCO_3$ content and pHof soils which might due to the formation of less soluble compounds like $MnCO_3$ or $Mn(OH)_2$. The higher pH favors 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).

From the above results it is evident that the deficiencies of Zn, Fe and Cu in the soils were 92, 49 and 14 % respectively whereas available Mn was found adequate in all the soils.The available micronutrients had positive correlation with silt, clay, and organic carbon of soils whereas, negatively correlated with sand, calcium carbonate and pH of the soils. It is necessary to maintain a reserve pool by applying suitable dose of micronutrient fertilizers in the area where the deficiency has been observed.

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