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DTPA-extractable Zn, Cu, Mn and Fe in Trans-Gangetic Plains of Northern India

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Abstract Samples of surface soil, covering Trans-Gangetic Plains of northern India, were analysed for DTPA-extractable micronutrient cations and soil properties. The soils were alkaline in reaction with low salt content and low to medium in organic carbon content. These soils were somewhat calcareous in nature and loamy sand to sandy loam in texture. Considerable variability in the contents of different micronutrients was observed, however, mean value for available Zn, Cu, Mn and Fe were 0.37, 0.87, 7.11 and 4.91 ppm, respectively. Majority of the soils were deficient in Zn, marginal in Fe and sufficient in Cu and Mn. Available Zn, Cu, Mn and Fe were significantly and negatively correlated with pH and positively with orgqnic carbon. The multiple regression equations revealed 7, 23, 3 and 14% variations in available Zn, Cu, Mn and Fe, respectively, were accounted for by the combined effect of pH, EC, $CaCO_3$ and organic carbon contents. Organic carbon/organic matter was found to be the most effective soil parameter affecting the status of micronutrients in the soils.

Key words available micronutrients, soil properties, trans-Gangetic plains

The importance of micronutrients in limiting crop production in several countries of the world is well recognised (Sillanpaa 1982). India is divided into 15 resource development regions, out of which Trans-Gangetic Plain region of northern India represent an area of intensively cultivated land and has highly fertilizer responsive soils. With increased use of high analysis fertilizers and less use of organic manure, the marginal productivity in many parts of this region has declined. With the intensification of agriculture the soils have been depleted of various nutrients, including micronutrients. Therefore, a survey was conducted primarily covering Trans-Gangetic Plain region of Haryana to assess the available micronutrient status, to determine the application need and to examine the effect of some soil properties on micronutrient availability.

Materials and Methods

One thousand and seventy five soil samples (0-20 cm) from Hisar and Sirsa districts were collected from Haryana state representing Trans-Gangetic Plain region of India. Soil samples were analysed for pH, electrical conductivity (EC), $CaCO_3$ and organic carbon content following standard procedures. The available Zn, Cu, Mn and Fe in soils were extracted with DTPA extractant (Lindsay & Norvell 1978). The extracts were analysed for all the four micronutrient cations on an atomic absorption spectrophotometer using appropriate standards. Multiple regression equations were worked out between soil properties and DTPA extractable micronutrients in soil.

Results and Discussion

The range and mean values for some selected soil properties and DTPA extractable micronutrient cations in respect of Hisar and Sirsa districts and entire 1075 samples are given in Table 1. The soil pH and EC varied from 7.4 to 9.4 and 0.20 to 5.25 dSm^{-1} with mean values of 8.4 and 0.21 dSm^{-1}, respectively. The soils are alkaline in reaction and low in soluble salts. The organic carbon content of most of these soils was very low to medium (0.01 to

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Table 1 *Range and mean values of some soil properties and extractable micronutrients*

District (No. of samples)	pH (1:2)	EC (dSm^{-1})	$CaCO_3$ (%)	OC (%)	Zn	Cu	Mn	Fe
					($mg\ kg^{-1}$)			
Hisar (610)	7.35–9.40 (8.37)	0.20–5.25 (0.24)	0.00–5.62 (0.61)	0.01–1.30 (0.41)	0.03–2.08 (0.42)	0.20–4.80 (0.90)	1.68–14.90 (4.56)	0.87–26.95 (3.08)
Sirsa (465)	7.80–9.10 (8.39)	0.60–5.20 (0.17)	0.00–13.70 (1.16)	0.01–0.92 (0.25)	0.03–1.75 (0.32)	0.20–3.80 (0.84)	1.60–39.20 (10.46)	1.29–44.50 (7.31)
Overall (1075)	7.35–9.40 (8.40)	0.20–5.25 (0.21)	0.00–13.70 (0.85)	0.01–1.30 (0.34)	0.03–2.08 (0.37)	0.20–4.80 (0.87)	1.60–39.20 (7.11)	0.87–44.50 (4.91)

1.3%) with $CaCO_3$ content ranging from traces to 13.7%. The texture varied from sand to clay loam. Available zinc content varied between 0.03 and 2.08 mg kg^{-1}, with a mean value of 0.37 mg kg^{-1}, is in the range of alluvial soils of Haryana (Singh & Raj 1992). Considering the critical limit of 0.61 mg kg^{-1} (Singh & Shukla 1985), about 72% of all the soils fall in the category of low Zn status and crops grown on these soils are expected to respond to Zn application. In Sirsa district alone 89% of the soils fall in the category of low Zn status. Widespread Zn deficiency in Indian soils was reported by Katyal & Sharma (1991). DTPA-Zn showed negative relationship with pH (r=-0.13)** and positive with organic carbon content (r=0.27)**. The multiple regression equation showed that only 7% variation in extractable Zn was due to the integrated effect of all these soil properties (Table 2). The partial regression co-efficient, however, indicated a dominant influence of organic carbon content. According to Hodgson (1963) complexing agents generated by organic matter promote Zn availability in soils. DTPA-Zn was positively correlated with DTPA-Cu, -Mn and -Fe (r=0.27**, 0.11**, 0.12**), respectively, suggesting variation in their distribution depended upon common soil factors (Follect & Lindsay 1970). Extractable Cu ranged between 0.20 to 2.08 mg kg^{-1} soil with a mean value of 0.87 mg kg^{-1} seemed to be sufficient to meet the crop requirement taking the critical level of 0.20 mg kg^{-1} (Lindsay & Norvell 1978). DTPA-Cu showed negative relationship with pH (r=-0.10**) and positive with EC, $CaCO_3$ and organic carbon (r=0.22**, 0.13**, 0.44**). The multiple regression equation showed that 23% variation in extractable Cu was due to the influence of pH, EC, $CaCO_3$ and organic carbon content. However, partial regression co-efficients suggest that organic carbon EC and $CaCO_3$ control the extractable Cu in these soils.

The DTPA-Mn varied between 1.60 and 39.20 mg kg^{-1} with an average of 7.11 mg kg^{-1}. Based on the critical value of 3.3 mg kg^{-1} of DTPA extractable Mn (Bansal & Nayyar 1990) availability of Mn does not seem to be problematic at present. Extractable Mn showed negative relationship with pH (r=-10**) and positive with organic carbon content (r=0.12**) and $CaCO_3$) (r =-11**) in soils.

The coefficient of multiple correlation in regression equation showed that only 3% variation in DTPA-Mn was due to the influence of pH, EC, $CaCO_3$ and organic carbon content. However, partial regression coefficients suggest that $CaCO_3$

Table 2 *Combined effect of soil properties on the DTPA extractable micronutrients*

		Multiple regression equation	R^2
Soil Zn	=	$1.74 + 0.03\ pH + 0.02\ EC + 0.01\ CaCO_3 + 0.45\ OC^{**}$	0.07
Soil Cu	=	$28.14 + 0.01\ pH + 0.27\ EC^{*} + 0.03\ CaCO_3^{*} + 1.18\ OC^{**}$	0.23
Soil Mn	=	$1614.27 - 1.23\ pH - 0.57\ EC + 0.27\ CaCO_3^{*} + 3.34\ OC^{**}$	0.03
Soil Fe	=	$918.04 - 0.78\ pH + 0.43\ EC + 0.82\ CaCO_3^{**} + 4.31\ OC^{**}$	0.14

and organic carbon content control the extractable Mn in these soils.

Extractable Fe varied from 0.87 to 44.50 mg kg^{-1} with an average value of 4.91 mg kg^{-1}. Considering 2.0 mg kg^{-1} DTPA-Fe as critical level (Takkar & Randhawa 1978), about 37% samples are deficient on an overall basis and 35% in Sirsa district alone. The results show that next to Zn, deficiency of Fe may become a nutritional problem in these soils. Significant correlation with organic carbon ($r = 0.22^{**}$), $CaCO_3$ ($r = 0.33^{**}$) and pH ($r = 0.18^{**}$) suggest that these soil properties largely influence the Fe status in these soils. The multiple regression equation indicated that 14% variation in extractable Fe was due to the integrated effect of all the soil properties. The partial regression coefficient, however, suggest the dominant effect of organic carbon and $CaCO_3$ content on the availability of Fe.

Organic carbon/organic matter was found to be the most effective soil property affecting the status of micronutrients in the soils under investigation. Therefore, alongwith commercial fertilizers, more use of bulky and concentrated manures like farm yard manure, compost, green manure and oil cakes, wood waste, etc., are suggested to improve organic matter status of these soils. Thus, with the increase in soil fertility status there will be improvement in the field crop production.

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