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Review Article

Soil Micronutrient Status Assessment in North Western Himalayas of India

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Abstract

The amount of micronutrients removed in harvested crops are generally much higher than the quantity added and hence resulting in exhaustive mining of micronutrients from the soil, thus increasing the micronutrient related stresses and yield losses. The problem has been further aggravated due to introduction of heavy nutrient feeders and high yielding hybrid varieties. Therefore, the present study was undertaken to study the micronutrient status of Saproon valley of H.P in surface and sub-surface soils, and tomato crop in order to get higher and sustainable production of vegetable crops. The pH ranged from 6.16 to 7.94 and EC of the surface and sub-surface soils ranged from 0.09 to 1.02 and 0.11 to 0.49 dS m^{-1}, respectively. The organic carbon content varied from 5.70 to 32.60 and 0.30 to 20.50 g kg^{-1} in the surface and sub-surface soils, respectively. DTPA extractable Fe and Mn content of the soils ranged from 7.03 to 24.16 mg kg^{-1} and 0.25 to 29.04 mg kg^{-1}, respectively. The results showed that average DTPA extractable Cu content of surface and sub-surface soils was 5.33 and 4.18 mg kg^{-1}, respectively and DTPA extractable Zn content of surface soils ranged from 0.01 to 4.23 mg kg^{-1}, with a mean value of 2.12 mg kg^{-1}. Addition of zinc along with FYM and N, P and K fertilizers will help in achieving higher and sustainable production.

Keywords: Soil fertility, micronutrients' status, Saproon Valley, Himachal Pradesh and sustainability

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Introduction

Soil testing provides the information about the nutrient accessibility of the soil that provides the clue for fertilizer recommendation to accelerate crop productivity. Zinc (Zn), Copper (Cu), Manganese (Mn) and Iron (Fe) are indispensable micro- nutrients for optimal plant growth. With their participation in a variety of enzymes and additional physiologically active molecules, these micro-nutrients are vital for gene expression, synthesis of proteins, nucleic acids, growth substances, chlorophyll, secondary metabolites, metabolism of carbohydrates and lipids, stress tolerance, etc. Presence of micro- nutrient in plants can be ascertained in direct uptake investigations or anticipated with techniques that compare the amount of micro-nutrients taken out chemically from the soils. The micronutrients like copper, iron, manganese and zinc are required by plants in minute quantities, although they are equally vital as major nutrients because of their role in plant development and crop productivity. Conversely, chief center of attention of the Indian fertilizer sector strategy has been on primary (macro) nutrients. The appliance of critical plant nutrients predominantly major and micro nutrients in most favorable quantity and right proportion through correct methods and time of application is the key to increased and sustained crop production. Therefore, it is important to understand fertilizers use behavior in the country over time as well as role of factors influencing fertilizer consumption at the national and regional / state level because intensity of fertilizer use varies from state to state and area to area.

The problem of micronutrient deficiency has been further aggravated due to introduction of heavy nutrient feeders and high yielding hybrid varieties. As the demand of nutrients for higher yields increases the plant's need for nutrients, nutrient deficiencies are likely to become more acute. As the limit of deficiency and toxicity in micronutrients is very narrow, the investment on a non-limiting nutrient is a waste and also has a deleterious effect on crops. In the present era of intensive agriculture, in view of sustainable crop production, it is being strongly felt that deficiency and sufficiency of nutrients must be assessed for different crops and locations. This valuable knowledge on the status of available micronutrients is essential to formulate the strategies for amelioration of such deficiencies, timely and more precisely. Therefore, the present study entitled "Soil Micronutrient Status Assessment in North Western Himalayas of India" has been reviewed under the following heads:

Appraisal of soil fertility status, DTPA-extractable iron, DTPA-extractable manganese, DTPA-extractable copper and DTPA-extractable zinc

Appraisal of soil fertility status

Soil fertility effects productivity of soils considerably. It is affected by the natural (climate, biosphere, parent material, topography and time) and artificial factors *viz*., management practices (fertilization, manuring, green-manuring, crop rotations etc.). The primary purpose of soil testing is to provide basis for location specific fertilizer recommendations for high yields. Parker *et al*. (1951) [1] advocated the use of Nutrient Index concept for comparing the levels of soil fertility between the soil series.

An effort has been made to review the fertility status of soils of Himachal Pradesh vis-à-vis India.

DTPA-extractable iron

Takkar and Nayyar (1981) [2] observed Fe deficiencies in cultivated alluvial plains of Punjab. Lahiri and Chakravarti (1989) [3] while studying the soils of Sikkim found that high altitude soils had high available iron content and high organic matter content than the low altitude soils due to the acidic pH. They observed an inverse relationship between availability of Fe and soil pH and found irregular distribution in the soil solum [4, 5]

Tripathi and Singh (1992) [6] observed significant correlation between DTPA-Fe and organic carbon (r=0.55**) which shows that available Fe in soils is largely influenced by organic carbon content.

Tripathi *et al*. (1994) [7] studied the distribution of micronutrients in the soils of Himachal Pradesh. They reported that available Fe varies from 15 to 41.2 mg kg^{-1} in the soils of Solan district of Himachal Pradesh. Mahajan (2001) [8] reported the soils of Mandi district in Himachal Pradesh as high in DTPA extractable Fe (91 to 129 mg kg^{-1}).

Singh (2001) [9] revealed 12 per cent of soils of India were deficient in available Fe. Amount of Fe varied from 3.3 to 205.0 mg kg^{-1} in the soils of some mulberry gardens of Karnataka and its content decreased with soil depth [10]. Karki *et al*. (2005) [11] reported low content of Fe (2.86 mg kg^{-1}) in high Himalayan region soils.

Sharma and Choudhary (2007) [12] reported that available Fe content in the soils of lower Shivaliks of Solan district ranged from 8.2 to 50.2 mg kg^{-1} and progressively declined with depth. Singh (2008) [13] revealed that soils of seven states *viz*., Bihar, Punjab, Haryana, Maharashtra, Madhya Pradesh, Tamil Nadu and Uttar Pradesh were deficient in available Fe to the extent of 18.6 per cent. As regards Indian soils, deficiency of available Fe was to the extent of 12.6 per cent.

Rattan *et al*. (2008) [14] found that the contents of Fe in Indian soils varied from 3.4 to 68.1 mg kg^{-1}. Singh (2009) [15] reported a deficiency of about 41 per cent in available Fe in soils of India.

Chander *et al.* (2014) [16] clearly stated that DTPA-extractable Fe varied from 10.6 to 70.8 mg kg^{-1} in sub-humid zone of Himachal Pradesh and 22.8 to 96.6 mg kg^{-1} in wet-temperate zone.

The literature clearly indicates a significant variation in available Fe content under different locations. In general, Indian soils were found to have sufficient and higher available Fe contents at different locations. Available Fe content has also showed decreasing trend with increasing soil depth.

DTPA-extractable manganese

Takkar and Nayyar (1981) [2] observed Mn deficiencies in cultivated alluvial plains of Punjab. The content of available Mn of the high altitude soils of Sikkim was lower than that of low altitude soils. The high organic matter content in high altitude soils formed insoluble complexes with Mn and reduced its availability (Lahiri and Chakravarti, 1989) [3].

Tripathi *et al.* (1994) [7] reported that average available Mn content in the soils of Himachal Pradesh was about 29.0 mg kg^{-1}. Significant Correlation of DTPA- Mn was found with organic carbon (r=0.28*). Mahajan (2001) [8] reported the soils of Mandi district in Himachal Pradesh as high in DTPA extractable Mn (1.3 to 3.5 ppm). Singh (2001) [9] revealed 5 per cent soils of India were deficient in available Mn.

Nazif *et al*. (2006) [17] have reported DTPA-extractable Mn to vary from 4.59 to 21.08 mg kg^{-1} at different locations in Jammu and Kashmir soils. Sharma and Choudhary (2007) [12] found that available Mn content in the profiles varied from 2.7 to 56.4 mg kg^{-1} and the contents declined with increase in profile depth in the soils of lower Shiwalik hills of Solan district.

Singh (2008) [13] revealed that soils of seven states *viz*., Bihar, Punjab, Haryana, Maharashtra, Madhya Pradesh, Tamil Nadu and Uttar Pradesh were deficient in available Mn to the extent of 10.5 per cent. As regards Indian soils, deficiency of available Mn was to the extent of 1.9 per cent. In Himachal Pradesh; 5 per cent of the samples studied were deficient in available Mn.

Sood *et al.* (2009) [18] observed that content of DTPA-Mn in the soils of Muktsar district of Punjab varied from 1.16 to 14.38 mg kg^{-1}. Singh (2009) [15] reported a deficiency of about 12 per cent of available Mn in soils of India.

Chander *et al.* (2014) [16] clearly stated that DTPA-extractable Mn varied from 2.1 to 34.9 mg kg^{-1} in sub-humid zone of Himachal Pradesh and 2.5 to 40.0 mg kg $^{-1}$ in wet-temperate zone.

The literature described above indicates that DTPA-extractable Mn status of the soil was found to be in deficient to sufficient range and it decreased with soil depth.

DTPA-extractable copper

DTPA-extractable Cu varied from 1.28 to 4.88 mg kg^{-1} in Saproon valley of Solan district [19]. In the soils of Kashmir, available Cu content in high altitude soils ranged from 0.07 to 0.33 mg kg^{-1}. DTPA-extractable Cu was found to be high in surface horizons and decreased with the increasing depth of profile [4]. The low altitude soils of Sikkim were high in available Cu than the one at high altitude [3].

Tripathi *et al.* (1994) [7] reported that the content of DTPA-Cu ranged from 0.4-4.8 mg kg^{-1}, with an average value of 1.7 mg kg^{-1}in the soils of Himachal Pradesh. Mahajan (2001) [8] reported the soils of Mandi district in Himachal Pradesh as high in Cu (1.7 to 2.8 mg kg^{-1}). Singh (2001) [9] revealed that 3 per cent of soils of India were deficient in available Cu. Sharma *et al*. (2002) [20] found that DTPA-extractable Cu ranged from 0.04 to 2.40 mg kg^{-1} in soils of Punjab

Karki *et al*. (2005) [11] recorded lower amounts of DTPA-extractable Cu (0.28 mg kg^{-1}) in the high Himalayan region of Nepal. Available Cu content in the soils of lower Shiwaliks of Solan district ranged from 0.30 to 2.80 mg kg^{-1} and it progressively decreased with depth [12].

Singh (2008) [13] revealed that soils of seven states *viz*., Bihar, Punjab, Haryana, Maharashtra, Madhya Pradesh, Tamil Nadu and Uttar Pradesh were deficient in available Cu to the extent of 3.6 per cent. As regards Indian soils, deficiency of available Cu was to the extent of 3.1 per cent. In Himachal Pradesh; 27 per cent of the samples studied were deficient in available Cu.

Rattan *et al*. (2008) [14] found that the contents of Cu in Indian soils varied from 0.2 to 5.0 mg kg^{-1}. Singh (2009) [15] reported a deficiency of about 4 per cent of available Cu in soils of India.

Sahoo *et al*. (2010) [21] characterized the fertility status of agricultural lands of Manipur and found that available Cu was sufficient and ranged from 0.76 to 3.06 ppm. Shilpashree *et al*. (2011) [22] revealed that soils of arecanut gardens in Karnataka were sufficient in Cu.

Chander *et al.* (2014) [16] clearly stated that DTPA-extractable Cu varied from 0.14 to 2.80 mg kg^{-1} in sub-humid zone of Himachal Pradesh and 0.02 to 3.60 mg kg" in wet-temperate zone.

DTPA-extractable zinc

Grewal *et al.* (1969) [22] in an extensive study of soils of Himachal Pradesh, reported that available Zn status of Kullu valley soils was marginal and it ranged from 0.38-0.60 mg kg^{-1} and from 0.05-0.68 mg kg^{-1} in surface and sub-surface soils with mean values of 0.52 and 0.34 mg kg^{-1}, respectively.

Sakal *et al*. (1986) [24] reported that the DTPA-extractable Zn in calcareous soils ranged from 0.34 to 3.42 ppm. The soil available Zn was negatively correlated with pH ($r=-0.41^{*}$) and positively correlated with organic carbon (r=0.71). The Bray's per cent yield ranged from 29.12 to 126.36 and was positively correlated with available Zn ($r=0.93^{**}$) and plant tissue Zn ($r=0.91^{**}$).

DTPA-extractable Zn contents were found to vary from 0.56 to 6.76 mg kg^{-1} in the temperate vegetable growing valley of Himachal Pradesh [18]. Further, Jalali *et al*. (1989) [4] have reported the DTPA-extractable zinc to vary from 0.35 to 0.65 mg kg^{-1} in the high altitude soils of Kashmir. They further reported that benchmark soils of Kashmir were deficient (0.15 to 1.00 mg kg^{-1}) in DTPA-extractable zinc.

Lahiri and Chakravarti (1989) [3] reported lower content of available Zn in the high altitude than the low altitude soils of Sikkim because of strong sorption of Zn by organic matter at high altitude soils.

Tripathi *et al.* (1994) [7] reported the distribution of micronutrients in the soils of Himachal Pradesh. The results showed that available Zn varied from 0.1 to 2.8 mg kg^{-1} in soils and its content, by and large, decreased with depth and coincided with the distribution pattern of organic carbon in the profiles.

Mahajan (2001) [8] reported that soils of Mandi district in Himachal Pradesh are high in DTPA extractable Zn (5.5 to 8.3 mg kg^{-1}). Sahoo *et al*. (2010) [20] characterized the fertility status of agricultural lands of Manipur and found that available Zn was sufficient and ranged from 0.58 to 1.52 ppm.

Chander *et al.* (2014) [16] clearly stated that DTPA-extractable Zn varied from 00.64 to 11.0 mg kg^{-1} in sub-humid zone of Himachal Pradesh and 0.44 to 2.06 mg kg^{-1} in wet-temperate zone.

The literature clearly indicates a significant variation in available Zn content under different soils. In general, emerging trend in Zn deficiency has been reported by different workers across the country.

Conclusion

The literature clearly indicates that Indian soils were sufficient and higher in available Fe contents at different locations Available phosphorus showed wide variation in its content at different locations of the country. DTPA-extractable Mn status of the soil was found to be in deficient to sufficient range and it decreased with soil depth. The literature clearly indicates a significant variation in available Zn content under different soils. In general, emerging trend in Zn deficiency has been reported by different workers across the country.

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