AVAILABLE COPPER, ZINC, MANGANESE AND IRON STATUS OF RAJASTHAN SOILS

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ABSTRACT

Soil samples representing Pellusterts, Chromusterts, Haplustalfs and Ustochrepts great groups of Rajasthan were collected and investigated for available content of micronutrient elements. Available (DTPA extractable) copper, zinc, manganese and iron were found to range between 0.18 ppm to 7.40 ppm, 0.20 ppm to 1.80 ppm, 2.05 ppm to 12.00 ppm and 1.5 ppm to 11.28 ppm respectively. Soils were adequate in available copper content, but deficient in available zinc followed by manganese and iron. Positive significant correlations were found between organic matter and available copper, zinc, manganese and iron. Available manganese and iron decreased significantly with calcium carbonate in some of the soil great groups under study. Available manganese decreased significantly with increase in pH only in Ustochrepts.

INTRODUCTION

Intensive cultivation of high yielding varieties and use of high analysis fertilizer disturb the nutrient balance in soil and micronutrients may become a limiting factor for increasing crop production. Thus, it is very essential to have a knowledge about available content of micronutrient elements in soils. The state of Rajasthan has widely different agro-climatic regions and wide variations in micronutrient content have been reported (Lal and Biswas 1974). The object of the present investigation was to assess the available copper, zinc, manganese and iron status of representative soils of Pellusterts, Chromusterts, Ustochrepts and Haplustalfs great groups of Rajasthan and to study relationship of some of the soil properties with their availability.

MATERIAL AND METHODS

Three hundred surface soil sample covering eight districts of four soil great groups of the state were collected. Available copper, zinc, manganese and iron were extracted with 0.005 M DTPA + 0.01 M CaCl₂ (Lindsay and Norvell 1978) and determined by Atomic Absorption Spectrophotometer. Soil properties were determined with usual standard laboratory procedures.
RESULTS AND DISCUSSION

Available copper, zinc, manganese and iron content in surface soil samples are presented in Table 1 and their correlation coefficient with pH, calcium carbonate and organic matter in Table 2.

**Available copper**: Available copper in these soils ranged from 0.18 ppm to 7.40 ppm. On an average Chromusterts (Bundi) contained a minimum amount of available copper (0.68 ppm) while Haplustalfs (Udaipur) contained maximum amount (1.87 ppm). Based on average values, the following descending order of available copper content in different districts of Rajasthan was observed:

- Banswara: 1.05 ppm
- Kota: 1.29 ppm
- Chittor: 1.60 ppm
- Bhilwara: 1.32 ppm
- Bundi: 1.09 ppm
- Jhalawar: 1.80 ppm
- Udaipur: 1.87 ppm

If the critical limits prescribed by Lindsay and Norvell (1978) i.e. 0.2 ppm is taken as criteria then all the soil samples under present study can be considered to have adequate quantity of available copper needed for plant growth. No consistent relationship between available copper and pH of soils was observed. In Chromusterts and Ustochrepts a negative non significant relationship was observed while in pellusterts and Haplustalfs, the relationship was positive non significant.

The results show that available copper increased with increase in organic matter content in all the soils. Correlations were significant for pellusterts \((r=0.394**)\) and Haplustalfs \((r=0.663*)\). The results are in agreement with the findings of Gupta et al. (1980b) who made similar observation.

**Available Zinc**: Available zinc content in these soils ranged from 0.20 ppm to 1.80 ppm. Soils of pellusterts group (Jhalawar) contained minimum amount (0.44 ppm) and Chromusterts (Kota) contained maximum amount (1.05 ppm) of available zinc. Based on the mean values, the following descending order of available zinc in different districts was obtained:

- Kota: 1.05 ppm
- Bhilwara: 0.80 ppm
- Banswara: 0.75 ppm
- Chittor: 0.74 ppm
- Dungarpur: 0.72 ppm
- Bundi: 0.68 ppm
- Udaipur: 0.48 ppm
- Jhalawar: 0.44 ppm

The variation might be due to differences in soil characteristics. If the critical limits of 0.6 ppm as prescribed by Takkar and Mann (1975) is taken as criteria, it can be said that 40 per cent samples are deficient in zinc. In general zinc was negatively and non significantly related with pH and calcium carbonate. With organic matter a positive significant correlation was found in Chromusters \((r=0.381**)\) and
<table>
<thead>
<tr>
<th>Soil group</th>
<th>District</th>
<th>No. of Samples</th>
<th>pH</th>
<th>Ca CO₃ (%)</th>
<th>OM (%)</th>
<th>Avl. Cu (ppm)</th>
<th>Avl. Zn (ppm)</th>
<th>Avl. Mn (ppm)</th>
<th>Avl. Fe (ppm)</th>
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</thead>
<tbody>
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<td>Pellusterts</td>
<td>Jhalawar</td>
<td>40</td>
<td>7.5-8.5</td>
<td>2.08-8.00</td>
<td>0.47-2.95</td>
<td>0.63-4.10</td>
<td>0.28-0.98</td>
<td>4.05-8.98</td>
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<td></td>
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<td>(8.15)</td>
<td>(6.10)</td>
<td>(0.88)</td>
<td>(1.80)</td>
<td>(0.44)</td>
<td>(5.25)</td>
<td>(4.28)</td>
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<td>Dungarpur</td>
<td>20</td>
<td>7.5-8.3</td>
<td>1.88-3.05</td>
<td>0.43-2.09</td>
<td>0.18-2.05</td>
<td>0.27-1.10</td>
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<td>3.60-9.50</td>
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<td></td>
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<td></td>
<td>(7.95)</td>
<td>(2.08)</td>
<td>(0.78)</td>
<td>(1.09)</td>
<td>(0.72)</td>
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<td>(4.80)</td>
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<td>7.4-8.8</td>
<td>1.20-5.20</td>
<td>0.45-2.04</td>
<td>0.38-4.05</td>
<td>0.60-1.70</td>
<td>2.05-8.05</td>
<td>2.70-10.59</td>
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<td>(8.20)</td>
<td>(3.85)</td>
<td>(1.08)</td>
<td>(1.29)</td>
<td>(1.05)</td>
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<td>(9.08)</td>
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<td>2.34-5.01</td>
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<td>0.88-7.40</td>
<td>0.37-1.38</td>
<td>2.88-12.00</td>
<td>1.80-3.95</td>
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<td>(8.20)</td>
<td>(4.00)</td>
<td>(3.05)</td>
<td>(3.05)</td>
<td>(0.75)</td>
<td>(6.05)</td>
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<td>0.16-1.85</td>
<td>0.20-1.38</td>
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<td>1.50-11.28</td>
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<td>(8.30)</td>
<td>(2.85)</td>
<td>(0.70)</td>
<td>(0.68)</td>
<td>(0.68)</td>
<td>(1.59)</td>
<td>(6.38)</td>
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<td>Ustochofrept</td>
<td>Bhilwara</td>
<td>40</td>
<td>7.8-8.8</td>
<td>3.00-8.05</td>
<td>0.70-3.10</td>
<td>0.27-3.06</td>
<td>0.30-1.69</td>
<td>2.87-11.85</td>
<td>4.50-10.00</td>
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<td>(8.25)</td>
<td>(4.88)</td>
<td>(0.90)</td>
<td>(1.32)</td>
<td>(0.80)</td>
<td>(6.85)</td>
<td>(5.70)</td>
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<td>Udaipur</td>
<td>50</td>
<td>7.5-8.9</td>
<td>1.15-10.08</td>
<td>0.70-2.40</td>
<td>0.75-2.95</td>
<td>0.27-1.80</td>
<td>2.80-7.50</td>
<td>1.85-5.09</td>
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<td>(8.30)</td>
<td>(3.88)</td>
<td>(1.01)</td>
<td>(1.87)</td>
<td>(0.48)</td>
<td>(4.87)</td>
<td>(3.08)</td>
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<td>Chittor</td>
<td>40</td>
<td>7.4-8.8</td>
<td>4.15-10.08</td>
<td>0.65-2.80</td>
<td>0.88-1.95</td>
<td>0.38-1.65</td>
<td>2.89-5.59</td>
<td>3.25-9.88</td>
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<td></td>
<td></td>
<td>(7.95)</td>
<td>(6.80)</td>
<td>(0.95)</td>
<td>(1.60)</td>
<td>(0.74)</td>
<td>(3.85)</td>
<td>(5.75)</td>
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</table>

* Figures in the parentheses are average values for the district.
<table>
<thead>
<tr>
<th>Soil group</th>
<th>No. of samples</th>
<th>Available Cu Vs</th>
<th>Available zinc Vs</th>
<th>Available manganese Vs</th>
<th>Available iron Vs</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>pH  CaCO₃  OM</td>
<td>pH  CaCO₃  OM</td>
<td>pH  CaCO₃  OM</td>
<td>pH  CaCO₃  OM</td>
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<tr>
<td>Pellusterts</td>
<td>60</td>
<td>+0.09  -0.09  +0.39**</td>
<td>-0.18  -0.13  +0.24</td>
<td>-0.13  +0.14  +0.13*</td>
<td>-0.18  -0.48**  +0.12</td>
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<td>Chromusterts</td>
<td>110</td>
<td>-0.11  +0.11  +0.12</td>
<td>-0.09  -0.10  +0.38**</td>
<td>+0.10  -0.19*  +0.27*</td>
<td>-0.03  -0.18*  +0.18</td>
</tr>
<tr>
<td>Ustoch-repts</td>
<td>40</td>
<td>-0.31  +0.03  +0.28</td>
<td>-0.05  +0.09  +0.13</td>
<td>-0.43*  -0.13  +0.18</td>
<td>-0.10  -0.61**  +0.31</td>
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<tr>
<td>Haplu-stals</td>
<td>90</td>
<td>+0.08  +0.08  +0.66**</td>
<td>-0.13  -0.14  +0.44</td>
<td>+0.08  -0.20*  +0.64**</td>
<td>+0.13  -0.13  +0.45*</td>
</tr>
</tbody>
</table>

** Significant at 1 per cent level ; * Significant at 5 per cent level
Available micronutrients: Available manganese in these soils ranged from 2.05 ppm to 12.00 ppm. On an average, Chromusterts (Bundi) contained minimum (1.59 ppm) and Ustochrepts (Bhilwara) contained maximum amount (6.85 ppm) of available manganese. Based on average values, the following descending order of available manganese content in different district under present study was observed:

- Bhilwara (6.85 ppm)
- Banswara (6.05 ppm)
- Kota (5.85 ppm)
- Jhalawar (5.25 ppm)
- Udaipur (4.87 ppm)
- Dungarpur (4.08 ppm)
- Chittor (3.85 ppm)
- Bundi (1.59 ppm)

Nearly 13 per cent soil samples can be treated as deficient if critical limit of manganese is considered to be 3 ppm (Sakal et al. 1986). Available manganese was negatively correlated with pH and CaCO₃. A positive significant correlation between available manganese and organic matter was found in all soil great groups except Ustochrepts where also it was positive though non significant.

Available iron: Available iron in these soils ranged from 1.50 ppm to 11.28 ppm. Based on average values, the following descending order of available iron in different districts of Rajasthan was observed:

- Kota (9.08 ppm)
- Bundi (6.38 ppm)
- Chittor (5.75 ppm)
- Bhilwara (5.70 ppm)
- Dungarpur (4.80 ppm)
- Jhalawar (4.28 ppm)
- Udaipur (3.08 ppm)
- Banswara (2.50 ppm)

Considering 4.5 ppm DTPA extractable Fe as critical level (Lindsay and Norvell 1978; Gupta and Potalia 1987) 12 per cent samples fall in deficient category. A low content of available iron in some of the soils is attributed to low content of organic matter, sandy texture and high pH of the soils. No consistent relation was found between available iron and pH, though it was usually negative and non significant. The inverse relationship between soil pH and available iron has been reported by Gupta et al. (1980) and Sakal et al. (1986). CaCO₃ showed a negative relationship with available Fe. Reduction in availability of iron with an increase in pH may be attributed to conversion of Fe²⁺ ions to Fe³⁺ ions which are not absorbed by plants. At high pH iron is also precipitated as insoluble Fe(OH)₂ and reduces its availability.

A significant positive correlation of Fe with organic carbon was found in Ustochrepts (r=0.31) and Haplustalfs (r=0.45), while in other Groups it was positive non significant. Similar relationship has also been reported by Gupta et al. (1980a).
in arid brown soils of Haryana. The positive effect of organic matter on the availability of iron may be attributed to supply of chelating agents formed by the product of decomposition of organic matter that help in maintaining the solubility of micro nutrients.

REFERENCES


