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Distribution of molybdenum and boron in some soils of northern alluvial plain of UP and Uttaranchal in relation to soil characteristics

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Molybdenum and boron are two important micronutrients anions as they involved in various physiological and enzymatic activities in the plants. Among micronutrients, B deficiency in plant is second after Zn. Boron deficiency is widespread in soils of several states leading to low productivity of crop. Available B and Mo content in Indian soils ranged from 0.08-2.6 and 0.07 –7.67 mg kg^{-1}, respectively and about 33% soils tested to be deficient in B (Singh 2001). Availability of Mo and B is greatly influenced by soil characteristics like pH, EC, CEC, organic matter, particle-size and free $CaCO_3$ content. Detailed information regarding distribution of B and Mo in surface and sub-surface soils of northern alluvial plain of Uttar Pradesh and Uttaranchal is lacking and hence the present study was undertaken.

One hundred surface and twenty four sub surface soil samples from four representative pedons (Duniapur, Shankerpur, Kalinagar and Bagwala) were collected from Rohilkhand plains and Tarai regions of U.P. and Uttaranchal, respectively. Soil samples were taken at an interval of 0-15, 15-30, 30-45, 45-60, 60-75 and 75-90 cm. These were air dried, ground, passed through a 2 mm sieve and analysed for pH, sand, silt, clay, organic C, EC, CEC, calcium carbonate equivalent using standard procedures. Available quantities of Mo and B in soils were extracted by ammonium oxalate (Grigg 1953) and hot water (Gupta 1979), respectively and determined as per procedure described by Singh *et al.* (1999). Simple correlations were worked out to relate extractable Mo and B with different properties of the soils.

In surface soils, the pH and EC ranged from 5.6 to 8.3, 0.18 to 2.08 dSm^{-1}, respectively and tended to increase with depth. Similarly CEC ranged from 8.03 to 21.8 c mol (P^+) kg^{-1}, $CaCO_3$ equivalent from 2.0 to 8.0 gkg^{-1} and organic carbon from 3.9 to 16.5 gkg^{-1}. Organic carbon, CEC and clay decreased with depth. Decrease in CEC of soil is owing to the decrease in organic carbon and clay. The $CaCO_3$ of soils did not show any definite distribution with depth (Table 1). The available B and Mo varied from 0.17 to 3.57 and 0.04 to 1.5 mg kg^{-1}, respectively with a mean value of 0.62 and 0.30 mg kg^{-1}. Most of the soils are considered to be low in available B as it has been reported that < 1 mg kg^{-1} B are not generally high enough for optimum plant growth (Reisenaure *et al.*1973). Bansal *et al.* (1991) reported a range of 0.3 to 2.0 mg kg^{-1} hot water extractable B in some soils of Punjab.

Available Mo varied from 0.04 to 0.59 mg kg^{-1} (mean value of 0.165 mg kg^{-1}). Sharma *et al.* (1988) reported available Mo ranging from 0.02 to 0.40 mg kg^{-1} in soils of Himanchal Pradesh. The hot water extracted B varied from 0.12 to 0.49 mg kg^{-1} (mean value of 0.34 mg kg^{-1}). Moafpouryan and Shukla (2004) reported that the value of hot water extractable B varied from 0.14 to 0.36 mg kg^{-1} in Inceptisols of Delhi. Available Mo decreased with depth. This trend might be due to its close association with organic matter of soil as it has role in protection of Mo through anion adsorption and making it available in soil solution. This is further corroborated by a significant positive correlation of Mo with organic carbon (r = 0.795**). Kumar (1988) for soils of U.P. and Dixit (1992) for soils of Ramganga-Kosi inter basin also reported similar findings. However, the available B did not show any definite trend of distribution in soils except in P2 (Table 1). It had a significant positive correlation with clay content (r = 0.444**). Similar relationship was also reported by Singh (1998) for soils of Western UP. This study indicates the need of B application on soil test basis for obtaining potential crop yields.

Table 1. Soil properties, B and Mo content in soils

Depth (cm)	pH (1:2)	EC (1:2)	OC (g kg^{-1})	$CaCO_3$ (g kg^{-1})	CEC c mol (P^+) kg^{-1}	Clay (%)	Hot water extractable-B (mg kg^{-1})	Ammonium oxalate extractable-Mo (mg kg^{-1})
Pedon 1. Duniapur (Typic Ustochrept)								
0-15	7.6	0.31	7.9	4.1	10.26	20.4	0.40	0.17
15-30	7.6	0.35	6.7	4.8	10.40	19.6	0.37	0.16
30-45	7.7	0.33	6.0	5.0	9.86	18.6	0.38	0.12
45-60	7.7	0.38	5.7	6.0	8.09	15.3	0.26	0.09
60-75	7.8	0.41	5.4	5.0	8.21	12.8	0.41	0.08
75-90	8.0	0.53	4.2	7.4	9.86	10.4	0.44	0.08
Mean	7.7	0.39	6.0	5.4	9.45	16.2	0.38	0.12
Pedon 2. Shankerpur (Aeric Haplaquept)								
0-15	7.6	0.48	13.2	7.0	13.26	16.6	0.36	0.59
15-30	7.7	0.58	12.1	4.0	15.04	15.6	0.35	0.18
30-45	7.7	0.49	8.9	7.3	12.92	13.8	0.31	0.17
45-60	7.8	0.53	7.8	7.3	10.64	12.4	0.27	0.12
60-75	7.9	0.55	6.6	8.6	9.86	10.8	0.18	0.09
75-90	7.9	0.60	5.8	6.0	8.44	8.12	0.12	0.07
Mean	7.8	0.54	9.1	67	11.69	12.9	0.27	0.20
Pedon 3. Kalinagar (Typic Haplaquoll)								
0-15	6.8	0.34	13.1	7.0	11.91	16.4	0.35	0.53
15-30	6.9	0.32	12.0	6.0	11.83	14.8	0.31	0.41
30-45	7.4	0.37	8.6	7.5	12.43	12.6	0.26	0.29
45-60	7.3	0.39	6.9	8.3	13.00	10.4	0.20	0.16
60-75	7.2	0.34	3.8	7.9	10.96	10.4	0.35	0.09
75-90	7.0	0.33	2.6	8.0	8.69	8.8	0.44	0.04
Mean	7.1	0.35	7.8	7.5	11.47	12.2	0.32	0.25
Pedon 4. Bagwala (Udic Hapludoll)								
0-15	6.4	0.56	10.9	6.1	18.2	19.6	0.49	0.17
15-30	6.8	0.43	10.1	4.0	17.26	16.8	0.44	0.09
30-45	7.4	0.46	7.9	5.0	15.04	14.4	0.40	0.08
45-60	7.3	0.38	6.8	7.7	12.36	12.3	0.35	0.08
60-75	7.3	0.43	4.0	8.3	10.64	10.4	0.44	0.07
75-90	7.2	0.35	3.9	8.6	9.86	10.1	0.22	0.05
Mean	7.0	0.44	7.3	6.6	13.89	13.9	0.39	0.09

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