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Boron status in some soils of lower Tista catchment of West Bengal

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Abstract

Boron content of brown forest soils and Tarai soils of West Bengal were studied in twelve surface soil samples (0–0.15 m) from different locations. Studies indicated that the total boron content was adequate. The brown forest soils were coarse textured, acidic in nature with high organic matter content and the soils of Tarai region were light textured having poor cation exchange capacities. The available boron was found to be above the critical limit of 0.36 mg kg^{-1} for soils in Algarh, Kalimpong and Mirik brown forest soils and all the soils in Tarai region except in Falakata and Toofanganj soils. However, available boron for remaining soils representing Lava, Kalbung and Pedong, were in traces.

Additional keywords : Hill soils, total Boron, available Boron, critical limit.

Introduction

Boron is one of the essential micronutrients needed for normal growth and development of plants. Highly leached acid soils of northern Bengal pose serious problem of boron deficiency (Mani and Halder 1996, Saha and Halder 1998). So, the present investigation was initiated with twelve surface soil samples collected from different locations to understand boron status of brown forest soils and tarai areas.

Materials and methods

Surface samples (0-0.15 m) from different soils were analysed for pH, organic carbon, cation exchange capacity and clay content by following standard procedures. Available boron was determined as per the method outlined by Black (1965) and total boron was determined using curcumin reagent spectrophotometrically at 540 nm (Jackson 1973).

Table 1. Characteristics of soils developed on hill slopes and alluvial plain

Soils	Description	Location	Parent Material	Land Use
Loamy-skeletal, Typic Haplumbrepts	Moderately shallow, well drained, gravelly loam soil, occurring on steep side slopes with gravelly loam surface, moderate erosion and moderate rockines	Algrah	Granitic geneiss	Peach
Fine-loamy, Humic Dystrusteps	Deep, well drained, fine loamy soils occuring on steep side slopes with gravely loamy surface and severely eroded	Kalimpong	Granitic gneiss	Vegetables
Loamy-skeletal, Typic Udorthents	Moderately shallow, somewhat excessively drained, gravelly loam soils with loamy surface, moderate erosion and moderate rockiness	Lava	Granitic gneiss	Vegetables
Loamy-skeletal, Typic Udorthents	Moderately shallow, somewhat excessively drained, gravelly loam soil with loamy surface, moderate erosion and moderate rockiness	Kalbung	Granitic gneiss	Vegetables
Loamy-skeletal, Typic Dystrusteps	Moderately shallow, well drained, gravelly loam soils occurring on very steep side slopes with gravelly loam surface and severely eroded	Mirik	Granitic gneiss	Tea
Loamy, Aeric Haplaquepts	Very deep, poorly drained, fine loamy soils on level to nearly level recent alluvium plain with loamy surface	Moinaguri	Alluvium	Paddy
Coarse-loamy, Aquic Ustifluvents	Very deep, imperfectly drained, coarse loamy soils occurring on level to nearly level recent alluvial plain with loamy surface and moderate flooding	Tufanganj	Alluvium	Wheat
Coarse-loamy, Typic Ustifluvents	Very deep, moderately well drained, coarse loamy soils	Dinhata	Alluvium	Paddy
Fine loamy, Typic Haplaquepts	Very deep, poorly drained, fine loamy soils with slight erosion	Cooch behar	Alluvium	Paddy
Coarse-loamy, Typic Haplaquepts	Very deep, coarse loamy soils, occurring on level to nearly level lower piedmont plain with loamy surface	Falakata	Alluvium	Paddy
Coarse-loamy, Typic Fluvaquents	Very deep, poorly drained, coarse loamy soils occuring on level to nearly level recent alluvial plain with loamy surface	Jalpaiguri	Alluvium	Paddy

Results and discussion

Soils of lower Tista catchment have been developed under two different pedological environments (Table 1).

Soils of side slopes of hill are moderately shallow to moderately deep, excessively drained with high organic matter. Soils developed on alluvium of river Tista are moderately deep to very deep, imperfectly drained and under intensive cultivation of rice and tea. Brown forest soils were developed on gneissic parent material in perhumid climate. They experience high rainfall and low temperature. Data indicated that soils vary considerably in physical and chemical properties (Table 2). They are very strongly to strongly acidic with pH values ranging from 4.3 to 5.6. Organic matter content in soil varied from 1.60 to 4.17%. The CEC of brown forest soils ranged from 8.84 to 12.50 [cmol (p+) kg^{-1}]. They are coarse textured to moderately coarse textured with clay ranging from 8.06% to 23.05%. Tarai soils are light textured with poor cation exchange capacities varying from 4.4 to 5.4 cmol (p+) kg^{-1}. The pH of the soils is slightly high.

The total boron content of the brown forest soils varied from 6.25 to 11.61 mg kg^{-1} with a mean value of 8.77 mg kg^{-1} (Table 2). Takkar and Randhawa (1978) reported that the total boron content in soils varied widely from 2.8 to 630.0 mg kg^{-1}. However, the total boron content is generally less in coarse textured soils than in heavy textured soils. The present study also indicated that coarse-textured hill soils contained less amount of total boron. Soils of tarai region have less total boron compared to brown forest soils. The values ranged from 4.31 to 5.12 mg kg^{-1}.

The available boron content of the soils are found to vary between 0.43 and 0.64 mg kg^{-1} (Table 2). However, in soils of Lava, Kalbung and Pedong the available boron content was in traces. Trace amount of available boron was also reported in acidic soils by Singh and Sinha (1976). Leaching losses of non-ionised H_3BO_3 molecule which is theoretically known to be the most predominant form under acidic conditions may also be responsible for trace quantity of available boron in such soils (Kanwar and Singh 1961). In case of Tarai soils, it is observed that the available boron content ranged from 0.36 to 0.66 mg kg^{-1}. Hence the soils do not suffer boron deficiency.

Table 2. Physical and chemical characteristics and boron status of soils

Location	pH	OM (%)	CEC [cmol (p+) kg^{-1}]	Textural class	Clay (%)	Total B (mg kg^{-1})	Available B (mg kg^{-1})
			Brown forest soils				
Algarh	5.6	1.60	10.5	Sandy loam	14.5	8.03	0.64
Kalimpong	4.9	3.86	11.9	Loamy sand	11.0	11.53	0.43
Lava	5.0	3.33	11.0	Loamy sand	15.2	8.33	0.05
Kalbung	4.3	4.17	12.5	Sand	8.1	11.61	0.05
Mirik	4.6	3.80	8.8	Sandy loam	14.0	6.25	0.461
Pedong	4.6	4.14	10.9	Sandy clay loam	23.0	6.88	0.05
			Tarai soils				
Moynaguri	5.0	2.13	5.0	Loamy sand	10.0	4.98	0.60
Toofanganj	6.0	1.76	5.3	Loamy sand	8.1	4.82	0.36
Dinhata	4.9	2.05	5.3	Sandy loam	12.0	5.08	0.66
Cooch behar	5.8	2.07	5.4	Loamy sand	9.5	4.57	0.39
Falakata	5.7	1.81	4.4	Sandy loam	11.9	4.31	0.36
Jalpaiguri	5.0	2.99	5.1	Loamy sand	6.2	5.12	0.66

Available boron in hill soils of West Bengal were reported to occur in the range between 0.05 to 0.76 mg kg^{-1} (Tandon 1995). Considering 0.36 mg kg^{-1} available boron to be the critical limit as suggested by Ali (1992), hill soils of Algarh, Kalimpong and Mirik were sufficient in available boron.

Total boron was correlated (Table 3) significantly and positively with CEC ($r=0.89^{**}$) and a negatively significant correlation existed between available boron and organic matter ($r = -0.57^{*}$). Singh and Singh (1967) also found negative but significant relationship between available boron and organic matter content in the soils. Soil properties, viz. pH, OC, clay and CEC contributed to 96.0 per cent variation in total boron as explained by the following relationship :

Table 3. Simple correlation coefficients (r values)

Soil Characteristics	Available Boron	Total Boron
pH	0.27	–0.38
OM	–0.57*	0.45
CEC	–0.55	0.89**
Clay	–0.42	0.13

TB = 9.47 – 0.99 pH – 1.639 OM + 1.222 CEC – 0.208 Clay .... (R^2 = 0.96**).

However, the contribution of the above soil properties on available B was 55 per cent as given by the following relationship :

Av B = 2.74 – 0.292 pH – 0.226 OM – 0.009 CEC – 0.0123 Clay .... (R^2 = 0.55*).

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