



Status of soil properties in relationship with soil pH in Madhupur tract of Tangail district in Bangladesh

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Abstract

The study was intended to investigate the status of soil properties and its relation to soil pH in Madhupur tract soil of Tangail district, Bangladesh. Thirty soil samples were collected during the period from June-July, 2016 covering four types of land as high land, medium high land, medium low land and low land. The interpretative data showed that the range of pH was strongly acidic to slightly acidic (5.27- 5.90), mean pH was slightly acidic (5.61). The organic matter (OM) status was medium (2.11 to 2.33 %) and mean OM was medium (2.24 %). The Nitrogen (N) status was low (0.11 to 0.13 %) and mean N status was medium (0.12 %). The range of the Phosphorus (P) status was found very low to medium (1.63 to 11.06 $\mu\text{g g}^{-1}$ soil) and mean P status was medium (7.37 $\mu\text{g g}^{-1}$ soil). The Potassium (K) status was low to very high (0.15 to 0.75 meq/100 g soil) and mean K status was low (0.18 meq/100 g soil). The range of the Sulfur (S) status was found from low to medium (11.73 to 16.31 $\mu\text{g g}^{-1}$ soil), mean S status was low (13.26 $\mu\text{g g}^{-1}$ soil). The range of the Zinc (Zn) status was found from medium to high (0.96 to 2.23 $\mu\text{g g}^{-1}$ soil), mean Zn status was optimum (1.55 $\mu\text{g g}^{-1}$ soil). The range of the Boron (B) status was found from medium to very high (0.39 to 0.86 $\mu\text{g g}^{-1}$ soil), mean B status was high (0.73 $\mu\text{g g}^{-1}$ soil). The Calcium (Ca) status was medium to optimum (4.42 to 5.23 meq/100 g soil), mean Ca status was optimum (4.83 meq/100 g soil). The Magnesium (Mg) status was optimum to high (1.21 to 1.75 meq/100 g soil), mean Mg status was optimum (1.37 meq/100 g soil). No significant correlation of OM and other nutrients with pH.

Key words: Soil properties, pH, organic matter, nitrogen, phosphorus

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Introduction

Soils of Bangladesh have been formed from different kinds of parent materials occurring in various topographic and drainage conditions. They are spread over three major physiographic units: (i) northern and eastern hills of Tertiary formations, covering 12% of the total area, (ii) Pleistocene terraces of Madhupur and Barind tracts, covering 8% of the total area, and (iii) Recent floodplains, mainly comprising alluvial sediments of the Ganges, Brahmaputra, and Meghna river systems, and occupying 80% of the country

(Saheed, 1984; Islam *et al.*, 2017a,b)). Madhupur Tract is also known as Bhawal Garh and Madhupur Garh. Madhupur formation represents highly oxidized reddish brown clay containing ferruginous nodules and manganese spots. The higher level lands are known as Chala, are used to cover by forests specially named as Sal forest and the valleys are called Baid, used for Boro rice cultivations in the dry season by impounding the water for irrigation. These are also extensively uses for upland crops like fruit garden (Jackfruit, Pineapple,

Banana, Mango, Bengal Olive, Pomelo, Star apple etc.), vegetables and year round crops (Sugarcane, Turmeric, Ginger etc.). The soil acidity is increased day by day in this area due to decreasing organic matter status because of intensive use of land (Karim *et al.*, 1994). The most common tree is the Sal (*Shorea robusta*), a major source of timber and fuel (Hossain *et al.*, 2010). Agricultural production is the main economic activity in our country. So, nutrient status of soil and their suitability maximum crop production should be ensured for better economic development of the country (ADAB News, 1979). The study was therefore, carried out: (i) to assess the soil organic matter and nutrients status (OM, N, P, K, S, Zn, B, Ca and Mg) of Madhupur Tract soil, and (ii) to determine soil pH and find out its relation to others nutrients.

Materials and Methods

The study was conducted during the period of June to December, 2016 in Madhupur Tract. The study area lies between 23°48' to 25°14' North Latitudes and 89°46' to 90°50' East Longitudes at the four upazila of Tangail district, Bangladesh. The study area was divided into four types of land namely high land, medium high land, medium low land and low land. Soil samples were collected from the agricultural land of the above four land types. The samples were collected from the study area within a depth of 15 cm (top soil). Total 30 soil samples were collected from different areas of these upazilas. The collected soil samples (500 g) were air dried, grind and sieved for analysis. In this study, the pH was determined by electrometric method (Davis and Freitas, 1970). The organic matter of the soil sample was measured titrimetrically according to Walkley and Black's wet oxidation method (Walkley and Black, 1934). Total N content of soil was determined by Micro Kjeldahl method. Available phosphorus was extracted from the soil by shaking with 0.03 M NH₄F – 0.025 M HCl solution at pH < 7.0 following the method of Bray and Kurtz method (Bray and Kurtz, 1945). The available calcium (Ca) and magnesium (Mg) contents were

extracted by ammonium acetate extraction method and determined by Ethylene-di-amine tetra acetic acid titration, Zinc of the soil sample was determined by '0.1N HCl (hydrochloric acid) extraction' method (Huq and Alam, 2005). The available sulphur in soil was determined by calcium chloride extraction method, Available potassium in soil was determined by ammonium acetate extraction method (Satter and Rahman, 1987). Boron was determined by hot water extraction method using a dilute calcium chloride solution (Berger and Truog, 1939). The Microsoft Office Excel software was used to present and interpret the collected data.

Results and Discussion

Table 1 showed that the pH of high land (HL), medium high land (MHL), medium low land (MLL) and low land (LL) were strongly acidic (5.35), slightly acidic (5.90), slightly acidic (5.76) and strongly acidic (5.27) respectively. The range of pH was found strongly acidic to slightly acidic (5.27- 5.90), mean pH of all the land types was slightly acidic (5.61). The optimum value of pH was found neutral (7.0) for the maximum crop production. Excessive acidity is detrimental to soil health. It increases soil toxicity and fixed available phosphorous (Hart *et al.* 2013). The OM values showed a negative correlation with pH ($r = -0.045$, $p < 0.01$) (Table 2). The organic matter (OM) status of the high land, medium high land, medium low land and low land were medium in all the land types (2.11, 2.31, 2.33 and 2.24 %) respectively. The range of OM status was medium (2.11 to 2.33 %), mean OM status of all the land types was medium (2.24 %).

High (3.41 %) OM status is the highly suitable for crop production. The Nitrogen (N) status of the high land, medium high land, medium low land and low land were low in all the land types (0.11, 0.12, 0.12 and 0.13 %) respectively. The range of the N status was found low (0.11 to 0.13 %), mean N status of all the land types was low (0.12 %). Optimum (0.27 %) N status is the suitable for crop production (BARC, 2018). The Phosphorus (P) status of the high land, medium high

land, medium low land and low land were medium, low, low and very low (11.06, 5.29, 7.78 and $1.63\mu\text{g g}^{-1}$ soil) respectively. The range of the P status was found very low to medium (1.63 to $11.06\mu\text{g g}^{-1}$ soil), mean P status of all land types was medium ($7.37\mu\text{g g}^{-1}$ soil). Optimum ($15.75\mu\text{g g}^{-1}$ soil) P status in the soil is suitable for crop production. The Potassium (K) status of the high land, medium high land, medium low land and low land were medium, low, medium and very high (0.23, 0.15, 0.19 and 0.75 meq/100 g soil) respectively. The range of K status was found low to very high (0.15 to 0.75 meq/100 g soil), mean K status

of all the land types was low (0.18 meq/100 g soil). Optimum (0.27 meq/100 g soil) K status in soil is suitable for crop production. The Sulfur (S) status of the high land, medium high land, medium low land and low land were low, low, medium and medium (13.15, 11.73, 16.31 and $15.71\mu\text{g g}^{-1}$ soil) respectively. The range of the Sulfur (S) status was found low to medium (11.73 to $16.31\mu\text{g g}^{-1}$ soil), mean S status of all the land types was low ($13.26\mu\text{g g}^{-1}$ soil). Optimum ($22.51\mu\text{g g}^{-1}$ soil) S status in soil is suitable for crop production.

Table 1. Status of the soil properties of Madhupur Tract soil (MT).

Soil nutrient	*HL Mean (±SD)	**MHL Mean (±SD)	***MLL Mean (±SD)	****LL Mean (±SD)	Average (±SD)	Optimum
pH	5.35 (±0.8)	5.90 (±0.54)	5.76(±0.23)	5.27(±0.45)	5.61(±0.65)	7.0
Status	Strongly acidic	Slightly acidic	Slightly acidic	Strongly acidic	Slightly acidic	Neutral
OM (%)	2.11 (±0.47)	2.31 (±0.45)	2.33(±0.48)	2.24(±0.34)	2.24(±0.44)	3.41
Status	Medium	Medium	Medium	Medium	Medium	High
N (%)	0.11 (±0.02)	0.12 (±0.02)	0.12(±0.02)	0.13(±0.02)	0.12(±0.02)	0.27
Status	Low	Low	Low	Low	Low	Optimum
P ($\mu\text{g/g}$ soil)	11.06 (±9.52)	5.29(±2.19)	7.78(±4.21)	1.63(±1.01)	7.37(±6.74)	15.75
Status	Medium	Low	Low	Very low	Low	Optimum
K (meq/100g)	0.23 (±0.11)	0.15(±0.05)	0.19(±0.08)	0.75(±0.15)	0.18(±0.08)	0.27
Status	Medium	Low	Medium	Very high	Low	Optimum
S ($\mu\text{g/g}$ soil)	13.15 (±5.78)	11.73 (±5.50)	16.31 (±9.66)	15.71(±6.45)	13.26(±6.19)	22.51
Status	Low	Low	Medium	Medium	Low	Optimum
Zn ($\mu\text{g/g}$ soil)	1.56 (±0.59)	1.49(±0.87)	0.96(±0.30)	2.23(±2.07)	1.55(±0.94)	1.35
Status	Optimum	Optimum	Medium	High	Optimum	Optimum
B ($\mu\text{g/g}$ soil)	0.73 (±0.24)	0.86(±0.15)	0.61(±0.14)	0.39(±0.36)	0.73(±0.25)	0.45
Status	High	Very high	High	Medium	High	Optimum
Ca (meq/100g)	4.56 (±3.77)	5.23(±2.43)	4.42(±2.66)	4.76(±2.06)	4.83(±2.88)	4.51
Status	Optimum	Optimum	Medium	Optimum	Optimum	Optimum
Mg (meq/100g)	1.31 (±0.84)	1.37(±0.58)	1.21(±0.57)	1.75(±0.85)	1.37(±0.69)	1.13
Status	Optimum	Optimum	Optimum	High	Optimum	Optimum

Note: *HL=High Land; **MHL=Medium High Land; ***MLL=Medium Low Land; ****LL= Low Land

Soil properties and its relation to pH

The Zinc (Zn) status of the high land, medium high land, medium low land and low land were optimum, optimum, medium and high ($1.56, 1.49, 0.96$ and $2.23 \mu\text{g g}^{-1}$ soil) respectively. The range of the Zn status was found medium to high (0.96 to $2.23 \mu\text{g g}^{-1}$ soil), mean Zn status of all the land types was optimum ($1.55 \mu\text{g g}^{-1}$ soil). Optimum ($1.35 \mu\text{g g}^{-1}$ soil) Zn status in soil is suitable for crop production. The Boron (B) status of the high land, medium high land, medium low land and low land were high, very high, high and medium ($0.73, 0.86, 0.61$ and $0.39 \mu\text{g g}^{-1}$ soil) respectively. The range of the Boron (B) status was found medium to very high (0.39 to $0.86 \mu\text{g g}^{-1}$ soil), mean B status of all the land types was high ($0.73 \mu\text{g g}^{-1}$ soil). Optimum ($0.45 \mu\text{g g}^{-1}$ soil) B status in soil is suitable for crop production. The Calcium (Ca) status of the high land, medium high land, medium low land and low land were optimum, optimum, medium and optimum ($4.56, 5.23, 4.42$ and $4.76 \text{meq}/100 \text{ g soil}$) respectively. The range of the Ca status was found medium to optimum (4.42 to $5.23 \text{meq}/100 \text{ g soil}$), mean Ca status of all the land types was optimum ($4.83 \text{meq}/100 \text{ g soil}$). Optimum ($4.51 \text{meq}/100 \text{ g soil}$) Ca status in soil is suitable for crop production. The Magnesium (Mg) status of the high land, medium high land, medium low land and low land were optimum, optimum, optimum and high ($1.31, 1.37, 1.21$ and $1.75 \text{meq}/100 \text{ g soil}$) respectively. The range of the Mg status was found optimum to high (1.21 to $1.75 \text{meq}/100 \text{ g soil}$), mean Mg status of all the land types was optimum ($1.37 \text{meq}/100 \text{ g soil}$). Optimum ($1.13 \text{meq}/100 \text{ g soil}$) Mg status in soil is suitable for crop production. The OM, N, P, K and S status were not suitable for agricultural crop production. But the Zn, B, Ca and Mg status were suitable for agricultural crop production in the study area.

The N, S, B, Mg and Ca values showed a positive correlation with pH ($r = .053, .297, .032, .275$ and $.210$), on the other hand OM, P, Zn and K values showed a negative correlation with pH ($r = -.045, -.164, -.220$ and $-.284$). No significant correlation of OM and other nutrients with pH (Table 2). The N, P, B,

Zn and Ca values showed a positive correlation with OM ($r = .827, .078, .191, .129$ and $.218$), on the other hand S, Mg and K values showed a negative correlation with OM ($r = -.191, -.089, \text{ and } -.059$). N value showed a significant correlation with OM ($r = .827, p < 0.05$) (Table 2). The Mg, K and Ca values showed a positive correlation with N ($r = .036, .110, \text{ and } .208$), on the other hand P, S, B and Zn values showed a negative correlation with N ($r = -.040, -.195, -.063$ and $-.016$). No significant correlation of other nutrients with N (Table 2). The B and Zn values showed a positive correlation with P ($r = .161, \text{ and } .041$), on the other hand S, Mg, K and Ca values showed a negative correlation with P ($r = -.130, -.488, -.190$ and $-.313$). Mg value showed a significant correlation with P ($r = -.488, p < 0.05$) (Table 2). The Zn, Mg, K and Ca values showed a positive correlation with S ($r = .194, .196, .128$ and $.049$), on the other hand B value showed a negative correlation with N ($r = -.252$). No significant correlation of other nutrients with S (Table 2). The Zn value showed a positive correlation with B ($r = .304$), on the other hand Mg, K and Ca values showed a negative correlation with P ($r = -.377, -.514, \text{ and } -.223$). Mg and K values showed a significant correlation with P ($r = -.377, p < 0.01$ and $r = -.514, p < 0.05$) (Table 2). The K and Ca values showed a positive correlation with Zn ($r = .201$ and $.056$), on the other hand Mg values showed a negative correlation with P ($r = -.239$). No significant correlation of other nutrients with Zn (Table 2). The K and Ca values showed a positive correlation with Mg ($r = .111$ and $.507$). Ca value showed a significant correlation with Mg ($r = .507, p < 0.05$) (Table 2). The Ca value showed a negative correlation with K ($r = -.076$). No significant correlation of other nutrients with K (Table 2).

Previous studies show that the range of pH status in Madhupur Tract soil was recorded very strongly acidic to slightly acidic (4.00 to 6.10), the range of OM status was very low to high (1.01 to 3.37%), the range of N status was very low to medium (0.04 - 0.26%), the range of P status was very low to very high (4.00 to 29.00

$\mu\text{g/g}$ soil), the range of S status was low to very high (10.00 to 72.00 $\mu\text{g/g}$ soil), the range of Mg status was very low to high (0.50 to 3.50 meq/100g soil), the range of Ca status was very low to medium (0.50 to 3.00 meq/100g soil), the range of K status was very

low to very high (0.08 to 0.72 meq/100g soil), the range of B status was low to very high (0.17 to 1.2 $\mu\text{g/g}$ soil) and the range of Zn status was recorded very low to medium (0.50 to 1.50 $\mu\text{g/g}$ soil) (Uddin *et al.*, 2016; SRDI, 2018).

Table 2. Correlation among the soil properties in Madhupur Tract soil (Values are shown as r = coefficient correlation).

	pH	OM	N	P	S	B	Zn	Mg	K	Ca
pH	1									
OM	-.045	1								
N	.053	.827**	1							
P	-.164	.078	-.040	1						
S	.297	-.191	-.195	-.130	1					
B	.032	.191	-.063	.161	-.252	1				
Zn	-.220	.129	-.016	.041	.194	.304	1			
Mg	.275	-.089	.036	-.488**	.196	-.377*	-.239	1		
K	-.284	-.059	.110	-.190	.128	-.514**	.201	.111	1	
Ca	.210	.218	.208	-.313	.049	-.223	.056	.507**	-.076	1

** Correlation is significant at the 0.01 level. * Correlation is significant at the 0.05 level.

Conclusion

The study was concluded that the mean of the pH indicated slightly acidic condition in all collected soils of the investigated area. This might be due to acidic parent materials, oxidation-reduction process and harvest of high-yielding crops. The OM status was medium but slightly decreasing trend. It might be intensive crop cultivation, more application of inorganic fertilizer and lack of incorporation of crop residues in the soils. The total N status was low in all the land types. It might be due to de-nitrification, leaching and immobilization of N from the soil. The P status was very low to medium. This might be due to soil acidity. Excessive soil acidity fixed the available P to the soil. The K status was low to very high. The S status of the study area was low to medium. The Zn status was found medium to high. The B status was found medium to very high. The Ca status was found medium to optimum and the Mg status was found optimum to high. This could be due to application of imbalanced fertilizer by the farmers. The study

concluded that pH, OM, N, P, K and S status was not suitable for agricultural crop production on the contrary the average Zn, B, Ca and Mg status was suitable for agricultural crop production. Proper management of crops and soils are needed for attaining optimum soil nutrient status and soils should be tested on a regular basis to determine its condition.

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