Asian J. Med. Biol. Res. 2016, 2 (4), 664-671; doi: 10.3329/ajmbr.v2i4.31012

Asian Journal of
Medical and Biological Research
ISSN 2411-4472 (Print) 2412-5571 (Online)
www.ebupress.com/journal/ajmbr

Article

Physicochemical properties of soil at Habla union of Basail upazila in Tangail

Md. Abdullah Miah[1], Nazia Uddin[1], Md. Mahbubul Hoque[1], Md. Erfanul Haq[2*] and Ajay Kumar Biswas[3]

[1]Department of Environmental Science and Resource Management, Mawlana Bhashani Science and Technology University, Santosh, Tangail - 1902, Bangladesh
[2]Department of Soil Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
[3]Department of Entomology, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh

*Corresponding author: Md. Erfanul Haq, Department of Soil Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh. E-mail: erfanulhaq.bd@gmail.com

Received: 20 November 2016/Accepted: 18 December 2016/ Published: 29 December 2016

Abstract: An experiment was conducted to examine the physicochemical properties of soil at Habla union under Basail upazila in Tangail based on the BINA (Bangladesh Institute of Nuclear Agriculture) laboratory analysis of physical and chemical parameters during January to March, 2014. Total 30 soil samples from 10 points of Habla union were collected from 0-15 cm, 15-30 cm, and 30-40 cm depth of the soil respectively. To determine the soil texture the results were compared with the standard value of SRDI and BARC. Among the 30 soil samples, 25 soils texture classes were found sandy clay loam, 4 were sandy clay and rest one was clay loam. The comparative analysis showed that the average texture class is sandy clay loam. The bulk density ranged from1.23 to 1.91 g/cm^3 for the total samples which leads to decide that bulk density is gradually increasing with soil depth. The moisture percentage at different depth of soil were 39.23 to 57.23 % (for 0-15 cm), 43.02 to 58.35 % (for 15-30 cm) and 42.08 to 58.24% (for 30-45 cm).The p^H obtained from soil samples of the study area were 4.66 to 5.55 (for 0-15cm), 5.37 to 6.18(for 15-30cm), 6.33to 6.60 (for 30-45 cm). The percentage of organic matter of the soil samples were 0.55 to 3.97 % (for 0-15cm), 0.55 to 3.24 % (for 15-30cm), 0.69 to 2.28 % (for 30-45cm).The organic matter content in the surface soil is relatively low compared to standard level that decreases steadily with depth. The percentage of nitrogen (N %) was observed in different depth of the soil were 0.078 to 0.126 % (for 0-15 cm), 0.049 to 0.126 % (for 15-30 cm), to 0.074 % (for 30-45 cm) which revealed that the percentages of total nitrogen were fall with the depth compared to standard level. In different depth of soil, it was observed that the level of phosphorus (P) was very low compared to standard level where the phosphorus (P) concentration of the soil samples were 1.18 to 2.90 mg/kg (for 0-15 cm), 1.30 to 9.95 mg/kg (for 15-30 cm), 1.58 to 10.92 mg/kg (for 30-45 cm). On the other hand, it was observed that the sulfur (S) concentration was increased with the depth of soil compared to standard level. The sulfur (S) concentration of the soil samples were 5.21 to 11.98 mg/kg (for 0-15 cm), 5.37 to 14.16 mg/kg (15-30 cm), 9.03 to 15.09 mg/kg (30-45 cm). The potassium (K) concentration of the soil samples were 0.038 to 0.102 mg/kg (for 0-15 cm), 0.031 to 0.90 mg/kg (for 15-30 cm) 0.055 to 0.171 mg/kg (for 30-45 cm), which indicated that the low K content compared to the standard level. The overall physicochemical parameter of soil samples were not optimum for good agricultural production. As we know all the parameters either directly or indirectly influence the soil fertility and productivity. This was probably the reason for low productivity of soil in the study area.

Keywords: physicochemical properties; soil fertility; environment; total nitrogen; soil pH; Bangladesh

1. Introduction

Soil, the topmost layer of the earth's crust, is one of the most important natural resource which has no substitute to sustain life on the planet. For ages it has served mankind with its precious components not only to build civilization but also to live on. In the 21th century a strong urge from the global leaders is to cope with the growing population in order to ensure food security; engendering soil and water use efficiency as a prime issue for economic development (FAO, 2016). For the developing countries like Bangladesh, agriculture is the second GDP (16.11%) earning sector; directly related to 60% of its population (BBS, 2014b). The main purpose of agriculture is to provide enough food for the increasing population (Shah *et al*., 2008). Crop production involves a complex interaction between the environment, soil parameters, and nutrient dynamics (Awal and Akhter**,** 2015). In the last decade agricultural land has been significantly reduced in Bangladesh (BBS, 2012a, 2014b). Soil fertility degradation is considered as an important cause for low production of many soils (Sanchez, 2002) in Bangladesh (FAO, 2016). Conventional farming are very efficient which produce high crop yields but can have a profound impact on the environment (Benites and Vaneph, 2001). For proper agricultural planning, sustainable land use, better crop production and evaluation of reclamation success research on physicochemical properties of soil plays a substantial role (Dexter, 2004). Soil chemical properties such as pH, base saturation, organic carbon and the levels of macro nutrients (N, S, P, K, Ca, Mg) and micronutrients (Cu, Co, Mn, Zn, Fe, B, Mo) in the soil have strong involvement in crop production (Hermiyanto *et al.,* 2016). This study was conducted to provide a detailed estimation of physicochemical properties of soil and agricultural using pattern in an agrarian area naming at Habla union under Basailupazila and to examine how these have affected crop diversity, productivity, food availability and ultimately the ecosystem. Thus, our study can be helpful for agricultural growth, productivity and efficiency in Bangladesh. Therefore, the objectives of the study were to know the present status of nutrients in the soil of the study area and to assess the physicochemical properties of soil at Habla union, Basailupazila in Tangail.

2. Materials and Methods

Study area is located between latitude 24°90′ and 24°18′ North and longitudes 89°58′ and 90° 58′ East. Characteristically, the experimental soil is under Sonatala soil series and Agro-ecologically, the soil belongs to AEZ 8 i.e. Brahmaputra river basin. Soil samples were collected following USDA (1951) soil survey method for three different depth range viz. 0-15 cm, 15-30 cm, and 30-40 cm. Soil textural classes were determined by the hydrometer method as outlined by Bouyoucos (1927).Soil moisture, bulk density analysis was done by the gravimetric method as described in (Alam and Huq, 2005). In estimation of bulk density, following equations were used:

Db= (Wo.d)/V

Where, Db = the bulk density of soil in g cm-3, Wo.d = the oven dry weight (g) of the soil filled in the core sampler, V= the volume (cm3) of the soil

Volume of the sample was calculated from the height and calculation of the diameter of sampling cylinder was done by using the following equation:

V=πDDh/4

Where, D=Diameter of the sampler, h=Height of the sampler.

Soil p^H was determined by the soil p^H and moisture meter ZD%PM 0909. The organic carbon of the soil sample was determined by Walkley and Black's wet oxidation method (Satter and Rahman, 1987).The % of organic matter in soil can be determined by using the following formula:

$$\text{\% of Organic carbon in soil} = \frac{(\mathrm{B} - \mathrm{T}) \times \mathrm{f} \times 0.003 \times 1.3 \times 100}{\mathrm{w}}$$

Where, B = Amount in ml of N $FeSO_4$ solution required in blank experiment, T = Amount in ml of N $FeSO_4$ solution required in experiment with soil, f = Strength of $FeSO_4$ solution (from blank experiment), W = Weight of soil taken.

The available phosphorus (P) of soil was determined by using the Olsen method /sodium bicarbonate method (Satter and Rahman, 1987).The % of Phosphorous in soil can be determined by using the following formula

$$\text{Available P} = \frac{\text{ppm from the standard curve} \times 50 \text{ ml volume of extraction} \times 50 \text{ ml (dilution)}}{\text{Amount of soil in g.} \times \text{ volume of extra used}}$$

The available potassium (K) in soil was determined by ammonium acetate extraction method [1] where astotal nitrogen (N) of soil samples were determined by Semimicro Kjeldahl method [2] and available Sulphur (S) in soil was determined by calcium chloride extraction method (Satter and Rahman, 1987). The following equations were followed:

ppm K in soil = Reading × factor from standard × dilution factor…………[1]

% available N= (T-B) N………………………………………………….... [2]

Where, T=sample titration, ml standard acid (H_2SO_4), B = Blank titration, ml standard acid (H_2SO_4), N = Normality of standard acid (H_2SO_4), S = Sample weight (g).

SPSS and Microsoft Excel program 2013 were used to process and analyze the data.

3. Results and Discussion

3.1. Soil bulk density

The bulk density of soil is a variable parameter and it varies due to the content of organic matter, texture, structure and total pore space in soil. The bulk densities of soil sample were shown in (Table 2). The bulk density of all soil samples were found to be ranged in between 1.23 to 1.62 g/cm^3 (for 0-15 cm), 1.29 to 1.53 g/cm^3 (for 15-30 cm), 1.52 to 1.91 g/cm^3 (for 30-45 cm). The bulk density of surface layer becomes low due to the presence of high porosity and high content of organic matter in comparison to deeper depth. Bulk density increased with increasing depth in the soil profile. This was due to lower organic matter content, less aggregation and more compaction of the soils of lower layer (Rahman, 1987).

3.2. Soil moisture

The percentage of soil moisture of all soil samples were found in (Table 2), which indicate that soil moistures were varying with depth. For instance, percentage of moisture of all soil samples were founded to be ranged in between 39.23 to 57.23% with the average value 49.532% (for 0-15cm), 43.02 to 58.35 % with the average value 51.73% (for 15-30cm), 42.08 to 58.24% with the average value 51.506% (for 30-45cm).

3.3. Soil texture

The study was investigated that the values of particle size ranges from 25.23-45.19% of our clay soil samples and their average was 30.58% (Table 1). The values ranges from 35.58-65.43% of silt samples and their average was 53.61% and the values range from 35.58-65.43% of sand soil samples and their average was 53.61%. The average texture class is sandy clay loam, which are not relevant to the standard level because the standard texture class is loamy (Piper, 1950).

3.4. Soil P^H

The p^H of all soil samples were found to be ranged in between 4.66 to 5.55 (for 0-15 cm), 5.37 to 6.18 (for 15-30 cm), 6.33to 6.60 (for 30-45 cm), which indicated that study area soils are acidic according to (Figure 1). Soil P^H from (6.5 to 7.5) was suitable for the most of the crop production. In which most soil nutrient were available to plants. Soil p^H depends on kinds of basic rock or parent materials. The low p^H at the surface layer might be due to the washing out and removal of basic captions by crop from the soil and the use of nitrogenous fertilizers. The decrease in exchangeable base levels and their possible replacement by exchangeable Al or exchangeable hydrogen suggested the increases in exchangeable acidity (Tamhane *et al.*, 1970).

3.5. Soil organic matter

It was observed that the percentage of organic matter of the soil samples are 0.55 to 3.97% (for 0-15 cm), 0.55 to 3.24% (for 15-30 cm), 0.69 to 2.28% (for 30-45 cm), which indicated that most of the soil samples were lower than standard level (Figure 3). The standard value of organic matter is 2.5% (SRDI, 2009). The maximum value (3.97%) was found on the samples no. 9 within the depth of 0-15 cm. However, minimum value (0.48%) was found on the sample no.5 within the depth of 15-30 cm. This may be due to the lower amount of the plant and animal tissue, sewage sludge, earthworms, ants because the main source of organic matter is the plant and animal tissue sewage sludge and earthworms responsible for the translocation of plant residues (Rai, 1998). Khan *et al.* (2002) also observed that in soil the low level of organic matter content might be due to higher oxidation rate of plant and animal residues by relatively higher temperature. According to BARC (2012) the organic matter of all the upland soils to be very low (OM< 1.00%). Soil organic matter status can be enriched by adding cow dung, compost and through green maturing.

3.6. Soil organic carbon

Percentage of organic carbon of all soil samples were found (Figure 2) to be ranged in between 0.32 to 2.29% with the average value 1.006% (for 0-15 cm), 0.28 to 1.88% with the average value 0.847% (for 15-30 cm), 0.40 to 1.32% with the average value 0.40% (for 30-45 cm). The standard value of organic carbon is 1.5% (SRDI, 2009). It was observed that most of the soil samples were lower than standard level. Organic carbon was decreased with depth. Organic carbons are closely related with organic matter. The highest value (2.29%) was observed at the samples no. 9 within the depth of 0-15 cm. The lower value (0.28%) was observed at the sample no.5 within the depth of 15-30 cm.

Table 1. Particle size analysis of soil.

Sampling No.	Particle size fractions and textural classes											
	0-15cm				15-30cm				30-45cm			
	Clay (%)	Silt (%)	Sand (%)	Soil texture	Clay (%)	Silt (%)	Sand (%)	Soil texture	Clay (%)	Silt (%)	Sand (%)	Soil texture
S_1	31.92	28.08	40.00	Clay loamy	28.57	19.04	52.39	Sandy clay loamy	28.03	18.09	53.28	Sandy clay loamy
S_2	35.57	3.84	64.43	Sandy clay	25.96	9.61	64.43	Sandy clay loamy	25.47	9.43	65.1	Sandy clay loamy
S_3	28.57	19.04	52.39	Sandy clay loamy	25.23	9.34	65.43	Sandy clay loamy	28.84	19.23	35.58	Sandy clay loamy
S_4	44.33	18.37	36.8	Sandy clay	25.47	9.43	65.1	Sandy clay loamy	35.57	3.84	64.43	Sandy clay loamy
S_5	28.03	18.9	53.28	Sandy clay loamy	25.23	9.34	64.3	Sandy clay loamy	28.30	18.86	52.84	Sandy clay loamy
S_6	31.92	28.08	40.00	Clay loamy	44.33	18.87	36.80	Sandy clay	25.23	9.34	64.43	Sandy clay loamy
S_7	25.47	9.43	65.1	Sandy clay loamy	28.84	19.23	51.93	Sandy clay loamy	28.03	18.9	53.23	Sandy clay loamy
S_8	25.47	9.43	65.1	Sandy clay loamy	28.03	18.09	53.28	Sandy clay loamy	25.23	9.34	65.43	Sandy clay loamy
S_9	45.19	19.23	35.58	Sandy clay	35.57	3.84	65.43	Sandy clay loamy	25.96	9.64	64.43	Sandy clay loamy
S_{10}	25.23	9.41	63.10	Sandy clay loamy	23.08	19.47	54.01	Sandy clay loamy	28.57	19.04	52.34	Sandy clay loamy

Table 2. Bulk density and moisture analysis of soil.

Sampling No.			Physical parameter					
			Bulk density (g/cm$^{3)}$			Moisture (%)		
0-15cm	15-30cm	30-45cm	0-15cm	15-30cm	30-45cm	0-15cm	15-30cm	30-45cm
S_1	S_1	S_1	1.31	1.52	1.75	50.96	54.08	49.58
S_2	S_2	S_2	1.28	1.40	1.72	49.22	43.02	48.23
S_3	S_3	S_3	1.40	1.29	1.69	53.53	58.35	52.80
S_4	S_4	S_4	1.58	1.30	1.68	57.1	59.23	58.24
S_5	S_5	S_5	1.35	1.41	1.70	41.32	47.23	42.08
S_6	S_6	S_6	1.49	1.53	1.71	39.23	45.08	51.43
S_7	S_7	S_7	1.23	1.45	1.52	47.30	51.29	55.02
S_8	S_8	S_8	1.62	1.53	1.75	45.35	50.09	48.21
S_9	S_9	S_9	1.40	1.39	1.68	57.23	54.03	53.01
S_{10}	S_{10}	S_{10}	1.43	1.52	1.91	54.08	54.90	56.46
Min			1.23	1.29	1.52	39.23	43.02	42.08
Mean			1.409	1.434	1.711	49.532	51.73	51.506
Standard deviation			0.127	0.092	0.095	6.248	5.417	4.718

Table 3. Analysis of N, P, K and Sofsoil.

Sampling No.			Chemical parameter											
			Nitrogen (%)			Phosphorus(mg/kg)			Sulfur(mg/kg)			Potassium(mg/kg)		
0-15cm	**15-30cm**	**30-45cm**	**0-15cm**	**15-30cm**	**30-45cm**	**0-15cm**	**15-30cm**	**30-45cm**	**0-15cm**	**15-30cm**	**30-45cm**	**0-15cm**	**15-30cm**	**30-45cm**
S_1	S_1	S_1	0.091	0.056	0.032	2.36	1.58	2.216	8.46	5.37	9.03	0.56	0.0501	0.096
S_2	S_2	S_2	0.126	0.049	0.035	1.18	2.05	2.058	10.61	8.79	12.22	0.049	0.031	0.055
S_3	S_3	S_3	0.112	0.077	0.028	8.08	2.79	6.282	11.21	9.76	10.49	0.047	0.040	0.070
S_4	S_4	S_4	0.105	0.070	0.039	2.76	5.02	2.899	11.98	10.23	12.70	0.054	0.052	0.114
S_5	S_5	S_5	0.084	0.084	0.027	6.66	6.35	5.857	8.86	8.79	9.76	0.038	0.037	0.070
S_6	S_6	S_6	0.80	0.070	0.018	6.45	9.95	10.92	5.21	8.79	11.95	0.064	0.044	0.118
S_7	S_7	S_7	0.102	0.126	0.032	2.90	6.53	6.506	9.87	8.30	12.49	0.066	0.405	0.081
S_8	S_8	S_8	0.092	0.112	0.055	2.36	1.77	2.058	8.86	9.28	10.90	0.088	0.603	0.114
S_9	S_9	S_9	0.089	0.051	0.0153	1.38	2.23	1.900	9.81	8.79	13.03	0.098	0.90	0.161
S_{10}	S_{10}	S_{10}	0.078	0.099	0.074	1.38	1.30	1.583	10.01	14.16	15.09	0.102	0.095	0.171
Min			0.078	0.049	0.0153	1.18	1.30	1.583	5.21	5.37	9.03	0.038	0.031	0.055
Mean			0.09	0.079	0.036	3.571	3.957	4.228	9.488	9.226	11.766	0.117	0.225	0.105
Standard deviation			0.015	0.026	0.018	2.50	2.88	3.063	1.85	2.164	1.769	0.157	0.307	0.039
Standard Value From SRDI, 2009			0.12	0.12	0.12	7.00	7.00	7.00	10	10	10	0.12	0.12	0.12

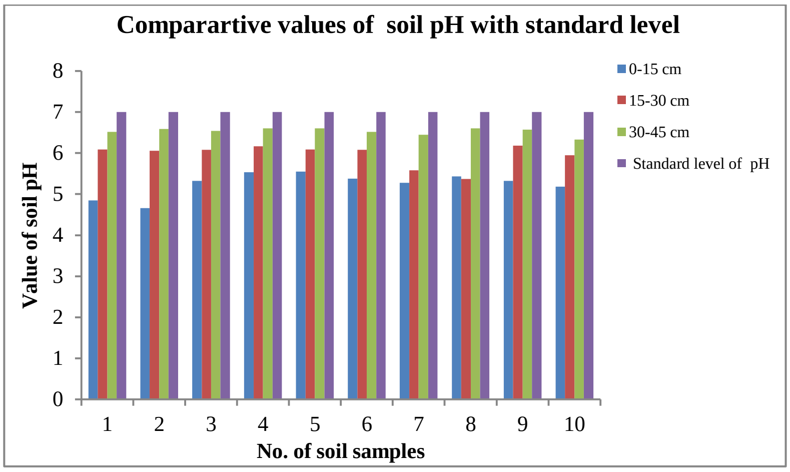

Figure 1. Present status of Soil p^H to the depth of 0-15 cm, 15-30 cm, and 30-45 cm.

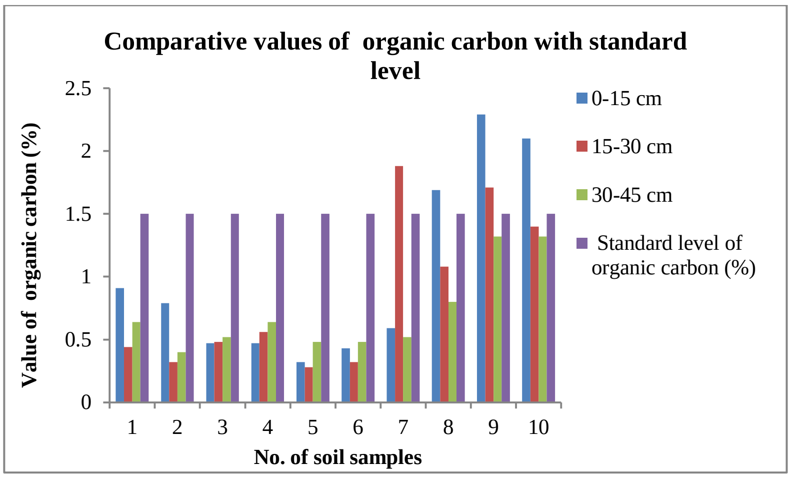

Figure 2. Present status of percentage of organic carbon to the depth of 0-15cm, 15-30 cm and 30-45cm.

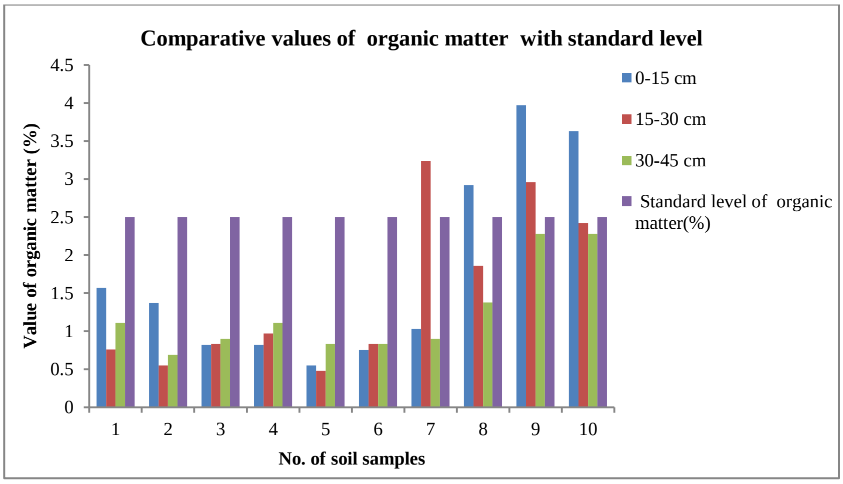

Figure 3. Present status of percentage of organic matter to the depth of 0-15 cm,15-30 cm and 30-45 cm.

3.7. Total nitrogen in soil

Nitrogen is the most important fertilizer element. Plants respond quickly to application of the nitrogen. Nitrogen is a major part of chlorophyll and the green color of plants. It was observed that percentage of total nitrogen of the soil samples were 0.078 to 0.126 % with the average value 0.0959% (for 0-15 cm), 0.049 to 0.126 % with the average value 0.07947 % (for 15-30 cm), 0.0153 to 0.074 % with the average value 0.036 % (for 30-45 cm) (Table 3). The percentages of total nitrogen are fall with depth. In the present study showed that total nitrogen of soil samples were lower than the standard level except soil samples no. 2 and 7 where the highest same value (0.126%) was found within the depth of 0-15 cm, and 15-30 cm respectively. It might be due to excess use of nitrogen fertilizer in the land for more production. The lower value (0.0135%) was observed at the sample no. 9 within the depth of 15-30cm. These results were very close to the findings of Portch and Islam (1984) who reported that, hundred percent soils of Bangladesh contained N below critical level. Bhuiyan (1988) reported that the total N percentage of different soil series of Bangladesh ranged from 0.05 to 0.22%.

3.8. Phosphorus present in soil sample

Phosphorus is an important nutrient for crop production. It is essential for photosynthesis activity of leaves. It increases the pulpiness of grains and resistance from diseases. The Phosphorus content of soil depends primarily upon the parent material and degree of weathering. It was observed that concentration of the phosphorus of the soil samples were 1.18 to 2.90 mg/kg within average value 3.571 mg/kg (for 0-15 cm), 1.30 to 9.95 mg/kg within average value3.957 mg/kg (for 15-30 cm), 1.58 to 10.92 mg/kg within average value 4.228 mg/kg (for 30-45 cm), which indicated that most of the soil samples were lower than standard level (Table 3). The highest concentration (10.92 mg/kg) of phosphorus was observed at sampling no.6 within the depth of 30-45 cm followed by sampling no.6 (9.95 mg/kg) within the depth of 15-30 cm and sampling no.3 (8.08 mg/kg) within the depth of 0-15 cm. This might be due to the over cultivation, insufficient input of replacement nutrients, accelerate soil erosion caused by inappropriate land uses and poor soil management practices, unbalanced fertilization (Sibbesen and Runge–Metzger, 1995). The lowest concentration (1.18 mg/kg) of phosphorus was also observed at sampling no.2 within the depth of 0-15 cm. Decrease the level of available phosphorus in agricultural land. Portchand Islam (1984) reported that 41% soils of Bangladesh contained phosphorus below critical level and 35 % below optimum level.

3.9. Sulfur present in soil sample

Sulfur is an essential nutrient for crop production especially in case of sweet corn. Present study showed that concentration of the sulfur of all the soil samples were found 5.21 to 11.98 mg/kg within average value 5.21 mg/kg (for 0-15 cm), 5.37 to 14.16 mg/kg within average value 5.37 mg/kg (for15-30 cm), and 9.03 to 15.09 mg/kg within average value 9.03 mg/kg (for 30-45 cm). Most of the soil samples were nearest with standard level while some of the soil samples were higher than standard level (Table 3). The highest concentration (15.09 mg/kg) of sulfur was observed at sampling no.10 within the depth of 30-45 cm. The lowest concentration (5.21 mg/kg) of sulfur also observed at sampling no.6 within the depth of 30-45 cm. This high level of S may be toxic for some of the crops. Khan *et al.* (2002) stated that the high Sulphur content in the surface soil suggests the use of acid sulphate soils as sulfidic fertilizers or acidic materials especially for S-deficient or calcareous soils. These findings are agreed with Islam (1992) who reported that the S deficiency in Bangladesh soils is becoming widespread and acute except the acid sulphate soils of Bangladesh. Portch and Islam (1984) reported that 68% soils of Bangladesh contained Sulphur below critical level and 14% below optimum level.

3.10. Potassium present in soil sample

Potassium is the third essential fertilizer element. Potassium is essential for photosynthesis, for protein synthesis, for starch formation and for the translocation of sugars. This is important for grain formation and is absolutely necessary for tuber development. All root crops are generally give response to application of potassium.

Present study showed that the concentration of the potassium of all soil samples were 0.038 to 0.102 mg/kg within the average value 0.1166 mg/kg (for 0-15 cm), 0.031 to 0.90 mg/kg within the average value 0.22571 mg/kg (for 15-30 cm), and 0.055 to 0.171 mg/kg within the average value 0.105 mg/kg (for 30-45 cm). The highest concentration (0.90 mg/kg) of Potassium was observed at sampling no.9 within the depth of soil sample was 15-30 cm, followed by the sampling no.8 (0.60 mg/kg) and sampling no.1 (0.56 mg/kg) and sampling no.7 (0.40 mg/kg) within the depth of soil samples were 15-30 cm, 0-15 cm, 15-30 cm respectively (Table 3). It may be due to the excess use of Potassium fertilizer in the land for more production (Henao and Baanante, 1999). The lowest concentration (0.031 mg/kg) of Potassium was observed at sampling no.2 within the depth of soil sample was 15-30 cm.

4. Conclusions

The present study provided the physicochemical properties of soil at Habla union, Basailupzila in Tangail. Soil quality is important for agricultural production. We tested soil samples in our selected area for the estimation of few physicochemical parameters. The P^H of all the soil samples of the study area was found to be acidic. The results showed that the range of p^H 4.66-5.55 (for 0-15 cm), 5.37 - 6.18 (for 15-30 cm), 6.33-6.60 (for 30-45 cm), the range of organic matter 0.55- 3.97% (for 0-15 cm), 0.55- 3.24% (for 15-30 cm), 0.69- 2.28% (for 30-45 cm), the range of total nitrogen of all soil samples were 0.07-0.126% (for 0-15 cm), 0.049 - 0.126% (for 15-30 cm), 0.0153- 0.074% (for 30-45 cm), the range of phosphorus of the soil samples were 1.18- 2.90 mg/kg (for 0-15 cm), 1.30 - 9.95 mg/kg (for 15-30 cm), 1.58 - 10.92 mg/kg (for 30-45 cm),the range of sulfur of the soil samples were 5.21 - 11.98 mg/kg (for 0-15 cm), 5.37 - 14.16 mg/kg (15-30 cm), 9.03- 15.09 mg/kg (30-45 cm), the range of the potassium of the soil samples were 0.038- 0.102 mg/kg (for 0-15 cm), 0.031- 0.90 mg/kg (for 15-30 cm) 0.055- 0.171 mg/kg (for 30-45 cm). All of the soil parameter values were to be found higher or lower than the standard level.

From the observations of the study following recommendations can be made:

a) Agricultural practices in the study area should be done at certain time interval.
b) Eco- friendly agricultural method can be applied.
c) Bio fertilizer can be applied.
d) Use of proper fertilizer and pesticides in the agricultural land for the management of NPKS level.

Conflict of interest

None to declare.

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