J. Environ. Sci. & Natural Resources, **4(2): 121-125, 2011** ISSN 1999-7361

Suitability of the Physical Properties of Soil for Crop Production: A Study in Tangail Sadar

S. A. Mamun[1], F. Rahman[1], F. Yeasmin[1] and M. A. Islam[2]

[1]Department of Environmental Science and Resource Management, Mawlana Bhashani Science and Technology University, Tangail-1902

[2]Department of Environmental Science, Bangladesh Agricultural University, Mymensingh-2202

Abstract

Use of imbalanced chemical fertilizer and changing crop and cropping pattern are becoming a serious threat for the sound environment of the soil. The study provided an assessment of the present status of soil quality of Tangail Sadar based on the laboratory analysis of physical parameters such as bulk density, water holding capacity, sand, silt and clay percentage from July, 2010 to December, 2010. 40 soil samples from 20 different places were collected from 0-15 cm and 15-30 cm depth of the soil from 5 locations mentioned as Porabari, Santosh, Gharinda, By-pass and Ashekpur. The study conducted revealed that among the 40 soil samples, 30 soil's textural classes are sandy clay loam, 7 are sandy clay and rests 3 are clay loam and the pH value ranges from 5.3 to 6.4. The comparative analysis shows that the average texture class is sandy clay loam, which is not relevant to the standard level because the standard texture class is loamy. The average moisture percentage, bulk density and water holding capacity are found 2.865 %, 0.0926 gm/cm^3 and 9.44% respectively which are almost similar to standard values and almost soil are suitable for plant growth.

Key words: Soil physical properties, Tangail, Comparison, Soil

Introduction

We grow plant on soil. Properties of soil that make it useful- provides water, nutrients and anchorage for plants and trees in natural forests and grasslands, annual and perennial crops and planted grassland. It provides the habitat for decomposer organisms which have an essential role in the cycling of carbon and mineral nutrients, acts as a buffer for temperature change and for the flow of water between the atmosphere and ground water, because of its ion exchange properties it acts as a pH buffer, and retains nutrient and other elements against loss by leaching and volatilization (Alan, 1996). Soils are not cover all over the earth's land. Non soil areas, which will not grow plants, include the ice lands of the polar and high-elevation regions, recent hard lava flow, salt flats, bare rock mountain slopes and ridges, and areas of moving dunes (Raymond and Roy, 1997). The vast importance of the soil in the development of various systems of agriculture and types of civilizations has long been recognized; but it is only within the last few decades that soils as such have been studied in a scientific manner. During thousands of years mankind has looked upon soils mainly from the utilitarian point of view. Today it is being realized more and more that the soil per se is worthy of scientific study, just as animals, plants, rocks, stars, etc., are subjects for theoretical research and thought. There is every reason to believe that any advance in the fundamental knowledge of soils will immediately fertilize and stimulate practical phases of soil investigations (Page, *et al*. 1989). Soil is a complex system made up of mineral matter, organic matter, and soil water and soil air. Therefore, it contains not only the solid and liquid phase but also the gaseous phase. Soil water and soil air are dependent variables and are controlled by amount and character of mineral matter and organic matter in soil. Thus soil is a three phase system with an indefinite number of components. The solid phase is made of mineral matter and organic matter. The liquid phase is composed of soil water and gaseous phase of soil air. The liquid phase is always in equilibrium with both the solid and gaseous phases. The physical properties of soil – Texture, structure, density, porosity water content, strength (consistency), temperature, and color are dominant factors affecting the use of a soil. These properties determine the availability of oxygen of soil, the mobility of water into or through soils, and the ease of root penetration. Soil water is a vital physical property. Additional soil physical properties include plasticity, stickiness, smarminess and fluidity. The chemical properties of soils are determined by the colloids of soils. Colloids are any substances whose particles are very small; thus, its surface properties are relatively more important than it's mass. Most colloids are smaller than a few micrometers (microns) in diameters. The chemical properties of soils include mineral solubility, nutrient availability, soil reaction (pH), and cation exchange buffering action. Clay has negatively charged sites in there lattices and attract and hole positively charged ions (cations) at the clay surface (Rai, 1998).

Day by day the soil mainly agricultural lands are degrading because the use of unbalanced chemical fertilizer and changing crop and cropping pattern become a serious threat for the soil. In this study, existing soil quality parameters are emphasized for plant growth on the soil. The soil physicochemical properties are compared with the standard values which are suitable for this area.

The objectives of the study were: i) to observe the physical properties of soil, ii) to observe the chemical properties of soil, iii) to compare the physicochemical properties of soil of Tangail Sadar with the standard values.

Materials and Methods

Study area

Tangail Sadar of Tangail district is situated in the western part of the district and is surrounded by Kalihati thana in north, Basail thana in south, Deldhuar and Nagarpur thana in east and Belkuchi and Chuhali thana of Sirajgong district in the west. It is also situated at the 24°09´ and 24°22´ North and 89°46´and 90°00´ East. Tangail is a district (zila) in central region of Bangladesh and is a part of the Dhaka division. The population of Tangail zila is about 3.2 million and surface area covers 3,414.39 km². The main town of Tangail District is the Tangail Sadar town. Tangail is surrounded by several districts, such as Jamalpur district in the north, Dhaka and Manikganj districts in the south, the Mymensingh and Gazipur districts in the east, and the Sirajganj district in the west. Tangail (town) consist of 18 words and 63 mahallas. The area of the town is 35.22 km^2. Administratively Tangail was established in 1870 and was turned into a district in 1989. The main rivers that cross the Tangail district are the Jamuna, Dhaleshwari, Jhenai, Bangshi, Lohajang, Langulia, Jugni, Fotikjani and the Turag.

Sample collection

The soil samples were collected for physiochemical analysis from Porabari, Santosh, Gharinda, By-pass and Ashekpur. Each sampling sites were divided into four sampling points, and from each sampling points, the bulk of soil samples representing 0-15 cm and 15-30 cm depth from the surface were collected by composite soil sampling method as suggested by the Soil Survey Staff of the USDA (1951). The samples were scraped from top to bottom with the help of an augar and mixed thoroughly. Samples were put in polythene bags, tagged with rubber band and labeled. For the bulk portion, samples were collected with spade.

Sample analysis

Particle size analysis was done by Hydrometer method, percentage of moisture present in the air-dried soil was determined by drying method. A known amount of soil were dried in an electric oven at 105^{o}C for 24 hours until constant weight was obtained and the moisture percentage was calculated by determining the loss of moisture from the samples, bulk density analysis was done by Core method, water holding capacity was determined by differences between drying known amount of soil in an electric oven at 105^{o}C for 24 hours until by determining the loss of moisture from the samples, soil pH was measured electrochemically by using a glass electrode pH meter at a soil: water ratio of 1:2.5, organic carbon of the soil sample was determined volumetrically by wet oxidation method of Walkley and Black, available phosphorus of soil was extracted by using the Bray and Kartz method. The extract was estimated colorimetrically following the blue color method using ascorbic acid. Extract was analyzed by a spectrophotometer at 882 nm, available potassium in soil was determined by flame analyzer after the soil was extracted with 1N ammonium acetate at pH 7, calcium and magnesium of soil samples were determined by classical routine method by complexometeric titration using EDTA as described in Huq and Alam (2005). The organic matter was determined by multiplying the percentage of organic carbon with conventional Van-Bemmelen's factor of 1.724 (Piper, 1950). The total phosphorus content of the soil was determined colorimetrically in a spectrophotometer at 420nm by developing yellow color with vanadomolybdate after the extract was collected by digesting the soil with aqua regia ($HCl:HNO_3$ :: 3:1), total potassium content in soil was determined by the aqua regia digestion method using concentrated HCl and concentrated HNO_3 in the ratio of 3:1. After collection of the extract the potassium content in soil was determined by Flame analyzer, total nitrogen of soil samples were determined by Kjeldahl's method following concentrated sulfuric acid (H_2SO_4) digestion as suggested by Jackson (1962). The distillation of digested samples was done with 40% NaOH and the distillate was collected on a 2% Boric acid mixed indicator. The distillate was titrated against N/100 H_2SO_4, Textural classes were determined by Marshall's Triangular Co-ordinates, as designed by the USDA (1951). Extraction of available S was made by 500 ppm P solution from calcium biphosphate with a soil to extracting ratio of 1:5 and 10 gm soil was taken. The S content was determined by turbid metric method and the turbidity was measured by a spectrophotometer at 420 nm, total sulfur was quantified on the aqua regia digest turbid metrically (Huq and Alam , 2005).

Statistical analysis

All the experimental data collected from different stations were statistically analyzed. Analyses were done by using SPSS statistical package (Evaluation Version 17.0), Microsoft office and Microsoft Excel. Finally the analyzed data were integrated and presented as tables, graphs and as explanation in the text.

Results and Discussions

The results gathered/obtained from the soil analysis are presented in Table 1.1, where L_1, L_2, L_3….L_{20} denotes location of the samples and L_{1-1}, L_{2-1}, L_{3-1}….L_{20-1} denotes 0-15 cm and L_{1-2}, L_{2-2}, L_{3-2}….L_{20-2} denotes 15-30 depth of soil samples respectively. There also use a figure of average texture classes of soil samples (Figure 1.) and a table of standard level of soil physical properties (Table 1.2) for comparison with present values from our study.

Table 1.1 Present status of some physical properties of the soil sample

Sample no.	Physical properties						
	Particle size analysis				Moisture percentage (%)	Bulk density (gm/cm^3)	Water holding capacity (%)
	Clay (%)	Silt (%)	Sand (%)	Soil texture			
L_{1-1}	35.57	3.84	64.43	Sandy clay	3.8	0.091	9.6
L_{1-2}	25.96	9.61	64.43	Sandy clay loam	3.8	0.091	9.6
L_{2-1}	44.33	18.87	36.80	Sandy clay	2.1	0.093	9.4
L_{2-2}	25.47	9.43	65.1	Sandy clay loam	2.1	0.093	9.4
L_{3-1}	31.92	28.08	40.00	Clay loam	2.0	0.092	9.5
L_{3-2}	28.57	19.04	52.39	Sandy clay loam	2.0	0.092	9.5
L_{4-1}	28.03	18.9	53.28	Sandy clay loam	3.5	0.094	9.3
L_{4-2}	25.23	9.34	65.43	Sandy clay loam	3.5	0.094	9.3
L_{5-1}	44.33	18.87	36.8	Sandy clay	2.9	0.093	9.4
L_{5-2}	25.47	9.43	65.1	Sandy clay loam	2.9	0.093	9.4
L_{6-1}	31.92	28.08	40.00	Sandy clay loam	2.8	0.092	9.5
L_{6-2}	28.57	19.04	52.39	Sandy clay loam	2.8	0.092	9.5
L_{7-1}	28.03	18.9	53.28	Sandy clay loam	3.0	0.094	9.3
L_{7-2}	25.23	9.34	65.43	Sandy clay loam	3.0	0.094	9.3
L_{8-1}	45.19	19.23	35.58	Sandy clay	2.3	0.091	9.6
L_{8-2}	28.84	19.23	51.93	Sandy clay loam	2.3	0.091	9.6
L_{9-1}	31.92	28.08	40.00	Sandy clay loam	3.8	0.092	9.5
L_{9-2}	28.57	19.04	52.39	Sandy clay loam	3.8	0.092	9.5
L_{10-1}	44.33	18.87	36.8	Sandy clay	2.0	0.093	9.4
L_{10-2}	25.47	9.43	65.1	Sandy clay loam	2.0	0.093	9.4
L_{11-1}	35.57	3.84	64.43	Sandy clay loam	2.3	0.091	9.6
L_{11-2}	25.96	9.61	64.43	Sandy clay loam	2.3	0.091	9.6
L_{12-1}	28.03	18.9	53.28	Sandy clay loam	3.8	0.094	9.3
L_{12-2}	25.23	9.34	65.43	Sandy clay loam	3.8	0.094	9.3
L_{13-1}	44.33	18.87	36.8	Sandy clay	2.9	0.093	9.4
L_{13-2}	25.47	9.43	65.1	Sandy clay loam	2.9	0.093	9.4
L_{14-1}	31.92	28.08	40.00	Clay loam	2.8	0.092	9.5
L_{14-2}	28.57	19.04	52.39	Sandy clay loam	2.8	0.092	9.5
L_{15-1}	44.33	18.87	36.8	Sandy clay	2.1	0.093	9.4
L_{15-2}	25.47	9.43	65.1	Sandy clay loam	2.1	0.093	9.4
L_{16-1}	25.96	9.61	64.43	Sandy clay loam	2.0	0.091	9.6
L_{16-2}	28.84	19.23	51.93	Sandy clay loam	2.0	0.091	9.6
L_{17-1}	31.92	28.08	40.00	Clay loam	3.0	0.092	9.5
L_{17-2}	28.57	19.04	52.39	Sandy clay loam	3.0	0.092	9.5
L_{18-1}	28.03	18.9	53.28	Sandy clay loam	2.9	0.094	9.3
L_{18-2}	25.23	9.34	65.43	Sandy clay loam	2.9	0.094	9.3
L_{19-1}	25.47	9.43	65.1	Sandy clay loam	3.8	0.093	9.4
L_{19-2}	28.30	18.86	52.84	Sandy clay loam	3.8	0.093	9.4
L_{20-1}	28.03	18.9	53.28	Sandy clay loam	3.5	0.094	9.3
L_{20-2}	25.23	9.34	65.43	Sandy clay loam	3.5	0.094	9.3

Table 1.2 Standard level of soil physical properties (Piper, 1950**)**

Parameters name	Standard level
Texture class	Loamy
Moisture percentage (%)	2.5-3.5
Bulk density (gm/cm^3)	0.05-1.00
Water holding capacity (%)	9.00-9.5

Comparison of the study sample with standard Value

Texture classes of soil samples

The study was investigated that the values of particle size ranges from 25.23-45.19% of our clay soil samples and their average is 30.58525% (Table 1.1) The values ranges from 35.58-65.43% of silt samples and their average is 53.61325% and the values range from 35.58-65.43% of sand soil samples and their average is 53.61325%(Table 1.1). The average texture class is sandy clay loam, which is not relevant to the standard level because the standard texture class is loamy (Piper, 1950).

Moisture

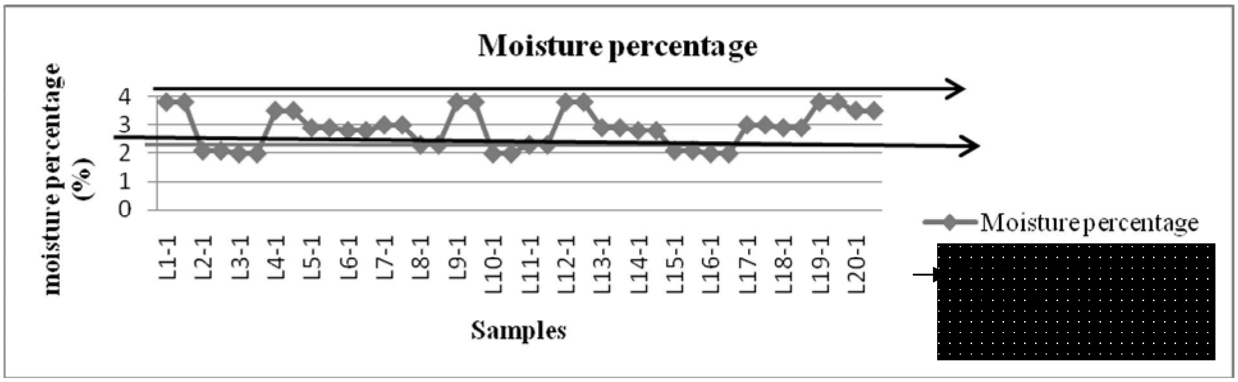

Figure 1. Status of moisture percentage

The range of moisture percentage of soil samples was found 2-3.8 % and there average was 2.865 % (Figure 1.) which was moderate because the standard level is 2.5-3.5 % (Piper, 1950). Most of the soil samples moisture percentages were found above the lower standard level but below the upper standard level.

Bulk density

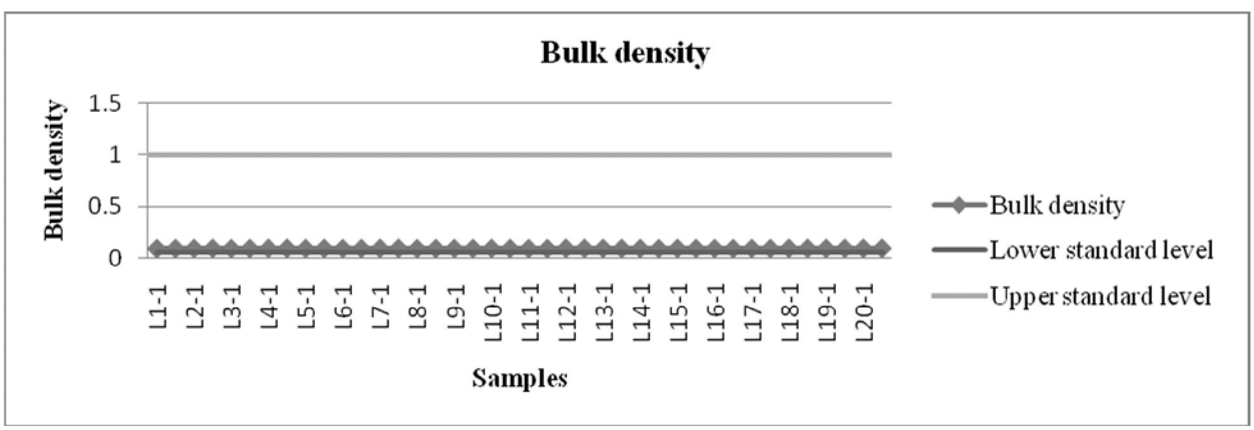

Figure 2. Present status of bulk density

Figure 2. shows that, the range of bulk density of soil samples were 0.09-0.094 gm/cm^3 and their average was 0.0926 gm/cm^3 which were moderate because the standard level was 0.05-1.00 gm/cm^3 (Piper, 1950).

Water holding capacity

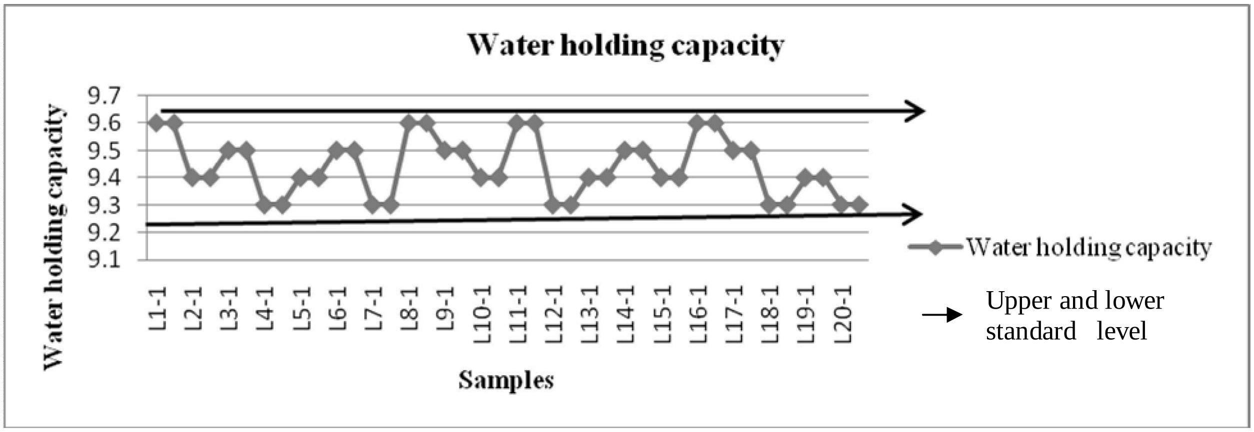

Figure 3. Status of water holding capacity.

The range of water holding capacity of soil samples was 9.3-9.6 % and there average was 9.44 % which was moderate (Figure 3.) because the standard level is 9.00-9.5 % (Piper, 1950).The upper and lower standard level was found 9.6 and 9.3 respectively. Most of the samples water holding capacity was within the standard level but 7 soil samples exceed the standard level.

Conclusion

From the six months study and foregoing discussion, it may be concluded that the most of the physical properties are similar to the standard level. These are moisture percentage, water holding capacity, bulk density but textural classes were not similar to the standard level (Piper, 1950). These results can also serve as a reference for the future studies of physical properties of soil status because without maintaining the standard level of soil, plants cannot grow properly.

References

Alan, W. 1996. Soil and the environment, Cambridge University Press. pp:1-36.

Huq, S. M. I. and Alam, M. D. (Eds.) 2005. A handbook on analysis of soil, plant and water. Bangladesh-Australia Centre for Environmental Research (BACER-DU), Dhaka. 31p.

Jackson, M. L. 1962. Soil Chemical Analysis, Prentice Hall Inc. Englewlld Cliffs, N. J. USA. pp:1-498.

Page, A. I.; Miiller, R . H. and Keeney, D. R. 1989. Methods of Soil Analysis, Part 2, 2nd Edn., *American Soc. Agron Inc. Madi Wis. USA*

Piper, C. S. 1950. Soil and Plant Analysis, The University of Adelaide Press, Adelaide, Australia, 368p.

Rai, M. M. 1998. Principles of Soil Science. Macmillan India Limited, New Delhi 110002, 3rd edn., pp:18-34.

Raymond, M. W. and Roy, D. L. 1997. Soil Formation: Building a Matrix for Living Organisms, Preview and Important Facts, Soil Physical Properties, Soils in Our Environment. Prentice Hall of Indian Private Limited, New Delhi- 110001, 7th edn., pp:95-127.

USDA (United States Department of Agriculture). 1951. Soil Survey manual by soil survey staff, Bereaw of plant industry. Soil and Agriculture Engineering, Handbook number 18:205.