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Assessment of Physical Properties of Soils of Dhalai District, Tripura, India

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ABSTRACT: An experiment was conducted in the Department of Soil Science and Agricultural Chemistry, SHUATS, Prayagraj, (Uttar Pradesh) India during 2020-2021 aiming to assess the Physical properties of soil from different blocks of Dhalai district, Tripura, India. The data revealed that the dry color of the selected soil samples ranged from reddish yellow to light grey, whereas the wet color ranged from strong brown to brown. Sandy clay loam was found in most of the communities and it was dominated by textural classes. Soil bulk density ranged from 1.05 to 1.25 Mg m^{-3} in different villages. Soil particle density ranged from 2.22 to 3.33 Mg m^{-3}. Pore space and water holding capacity were measured in percentages ranging from 45.45 to 68.82 percent and 48.38 to 77.56 percent, respectively. The specific gravity of the soils in several communities ranged from 1.66 to 2.78. There is no substantial difference in particle density due to depth, however, there is a considerable difference in particle size. Due to depth and position, there are considerable differences in bulk density, pore space, and water holding capacity. Because there is a scarcity of knowledge on layered characteristics of soil physical qualities in diverse sites around the Dhalai region, this study will surely benefit the village's agricultural community. This data will assist farmers in determining the amount of fertilizer required to improve the soil on their fields, as rich soils are required to raise healthy harvests. The downsides of totally adopting the organic farming system may be offset by the information gathered from this study and its effective implementation when required, despite the fact that the region has solely chosen organic farming since time immemorial.

Keywords: Physical properties, soil analysis, bulk density, water holding capacity.

INTRODUCTION

Physical properties analysis generally includes simple, fast, and low-cost methodologies. Bulk density, particle density, porosity, water holding capacity, soil color, texture, and specific gravity were all evaluated as physical attributes of soil (Beutler *et al.,* 2002). The bulk density of the soil was calculated using direct methods, which are recommended by agricultural soil scientists, researchers, and engineers (Ma *et al.,* 2013). The formula for Soil Bulk density estimation is mass of the oven-dried soil/volume of the oven-dried soil and usually, the unit is mg/m^3 (Campbell, 1994). In general, the soil is considered physically poor when it shows a low rate of infiltration, enhanced surface runoff, poor cohesion, low aeration, and root density, and difficulty for mechanization (Dexter, 2004). The bulk density of soil has increased naturally, resulting in pore gaps. Here Bulk density varies between 1.319 gm/cm^3 and 1.375 gm/cm^3. Because they were light-textured soil, the bulk density of the maximum area ranged from low to medium (Das and Mipun, 2021). The volume of soil gaps that can be filled by water or air is known as porosity or pore space. It is inversely related to bulk density and influenced by sizes, shapes, and degrees of packing (Viji and Rajesh, 2012). Because soil is a granular substance with different sizes and distances, there are spaces between them that are not filled with solid particles, which are referred to as pore spaces (Das, 2011). The water retention capacity and soil qualities are important in irrigation and dryland crop water management planning (Viji and Rajesh, 2012). Water is necessary for the growth of soil and plants. Specific gravity is the ratio of soil solid to a mass of an equal volume of water. Specific gravity is an important soil index attribute that is linked to mineralogy and chemical composition (Oyediran and Durojaiye 2011). Water infiltration, permeability, and water holding capacity are all influenced by the texture and structure of the soil (Vega and Jashothan 2012). A number of problems have been recognized as key contributors to the low output, including insufficient irrigation and inappropriate cultivation (Joshi and Tiwari 2013).

MATERIALS AND METHODS

A. Soil Sampling

Soil samples were collected from agricultural fields of 9 different villages, which fall under three community development blocks viz., Manu, Ambassa, Salema. Each village represented three profile depths viz., 0-15 cm, 15-30 cm, and 30-45 cm. Twenty-seven samples were collected in total. All the samples were collected using khurpi by a random selection. The samples were air-dried and all the unwanted materials were removed. Large clods were crushed by hand and a wooden mallet and then ground using wooden mortar and pestle. Grinding was followed by sieving for which a 2.0 mm sieve was used. Sieved soil samples were stored in air-tight plastic bags and tagged for estimation of physical properties.

B. Analysis of physical parameters

Soil textural analysis of particles less than 2 mm was performed by the Hydrometer method (Bouyoucos, 1927). The samples were matched against the standard Munsell soil color chart (Munsell, 1971) to obtain hue, value, and chroma combinations for soil color. The Graduated 100 ml Measuring Cylinder Method was used to determine bulk density, particle density, pore space, and water holding capacity (Muthuvel *et al.*, 1992). The specific gravity of soil was determined by the relative density bottle or pycnometer method as laid out by Black (1965).

C. Statistical Analysis

The data recorded during the course of an investigation was subjected to statistical analysis by the method of analysis of variance (ANOVA) technique (Fisher, 1960). The type of ANOVA adopted for the experiment was a two-factor analysis without replication. The implemented design of an experiment in the analysis done was Completely Randomized Design (CRD).

RESULTS AND DISCUSSION

A. Soil texture

Table 1 depicted the Soil texture (Sand, Silt, and Clay %) of different soil samples that were taken from respective depths (0-15, 15-30 cm, and 30-45cm) from different villages of Dhalai district, Tripura. The soil texture in V1 (Karaticherra), V4 (Balaram), V5 (Bagmara), V6 (Lalchhari), V8 (Kachucherra), and V9 (North Kachucherra) are dominantly Sandy clay loam. While the texture in V2 (Kathalcherra), V3 (Damcherra), and V7 (Halam para) are Sandy clay. The sand content varied from 56.68-76.85%, Silt varied from 1.09-16.42%, and Clay varied from 21.58-40.42%. Similar findings have also been observed by Bhattacharyya *et al.*, (2018).

Table 1: Evaluation of soil texture of different sites of Dhalai District Tripura.

Blocks/Sites	Sand (%)	Silt (%)	Clay (%)	Textural classes
Manu (B1)				
Karaticherra (V1)	76.85	1.57	21.58	Sandy clay loam
Kathalcherra (V2)	59.58	1.31	39.11	Sandy clay
Damcherra (V3)	60.89	1.09	38.02	Sandy clay
Ambassa (B2)				
Balaram (V4)	56.68	15.85	27.47	Sandy clay loam
Bagmara (V5)	60.11	16.42	23.47	Sandy clay loam
Lalchhari (V6)	71.53	4	24.47	Sandy clay loam
Salema (B3)				
Halam Para (V7)	59.58	1.31	40.42	Sandy clay
Kachucherra (V8)	76.85	1.57	21.58	Sandy clay loam
North Kachucherra (V9)	58	16.1	25.9	Sandy clay loam

B. Soil color

Table 2 represented the soil color of samples varies Reddish yellow to Light-yellowish brown in dry conditions and Brown to Yellowish-brown in wet conditions. The reddish-yellow color of the soil is due to well-draining or under condition, iron forms red oxide imparting red color to the soil, and the brown color is due to contains a relatively large amount of Iron oxide in addition to organic matter. The grey color of soil is due to water logged conditions, with a lack of air. Similar findings were found in line with Gangopadhyay *et al.*, (2015).

C. Bulk Density (Mg m^{-3})

The bulk density in soils from different villages varied from 1.05 to 1.25 Mg m^{-3}. The bulk density (Table 3) increases with the increase in soil depth due to compact pan horizons high organic matter, and less aggregation. The maximum mean soil bulk density of 1.22 Mg m^{-3} was found at V6 (Lalcheri) which indicates that soil has comparatively lower organic matter. The minimum mean soil bulk density of 1.07 Mg m^{-3} was found at V1 (Karaticherra) due to high tillage operation which loses the soil and natural soil-forming processes that increase aggregation. Similar findings were reported by Choudhary *et al.*, (2016).

Table 2: Soil color of different sites in the dry and wet conditions of Dhalai District Tripura at 0-15 cm, 15-30 cm and 30-45 cm.

Blocks/ Sites	0-15 cm		15-30 cm		30-45 cm	
	Dry	Wet	Dry	Wet	Dry	Wet
Manu (B1)						
Karaticherra (V1)	yellowish brown	Dark yellowish brown	Light yellowish brown	Dark brown	Pale brown	Dark yellowish brown
Kathalcherra (V2)	Yellowish brown	Dark yellowish brown	Brown	Dark brown	Light yellowish brown	Dark yellowish brown
Damcherra (V3)	Light yellowish brown	Yellowish brown	Pale brown	Greyish brown	Light brownish grey	Grey
Ambassa (B2)						
Balaram (V4)	Light yellowish brown	Dark brown	Light grey brownish	Dark brown	Pale brown	Dark greyish brown
Bagmara (V5)	Light yellowish brown	Yellowish brown	Pale brown	Yellowish brown	Yellowish brown	Brown
Lalchhari (V6)	Reddish yellow	Strong brown	Reddish yellow	Strong brown	Reddish yellow	Brown
Salema (B3)						
Halam Para (V7)	Brown	Dark brown	Brown	Dark brown	Pale brown	Dark greyish brown
Kachucherra (V8)	Light brownish grey	Dark yellowish brown	Light grey	Dark brown	Light grey	Dark greyish brown
North Kachucherra (V9)	Light yellowish brown	Yellowish brown	Pale brown	Dark brown	Brown	Dark greyish brown

D. Particle density (Mg m^{-3})

No significant difference was found in soil particle density due to depth where a significant difference was found between sites. The particle density (Table 3) in the soils from different sites varied from 2.22 to 3.33 Mg m^{-3}. The maximum mean soil particle density of 3.17 Mg m^{-3} was found at V1 (Kathalcherra) which indicate that soil has comparatively lower organic matter and the minimum mean soil particle density of 2.31Mg m^{-3} was found at V6(Lalcherivillage) which indicate that soil has comparatively higher organic matter about 15-20%. Particle density in the soil varies according to the mineral content of the soil particles. Similar findings were reported by Dey and Nath (2015).

Table 3: Bulk density, Particle density, and % pore space of different sites of Dhalai District Tripura at 0-15 cm, 15-30 cm, and 30-45 cm.

Blocks/ Sites	0-15 cm	15-30 cm	30-45 cm	Mean
Manu (B1)				
V1	1.05	1.05	1.11	1.07
V2	1.11	1.17	1.25	1.18
V3	1.05	1.11	1.17	1.11
Ambassa (B2)				
V4	1.05	1.11	1.17	1.11
V5	1.11	1.17	1.25	1.18
V6	1.17	1.25	1.25	1.22
Salema (B3)				
V7	1.05	1.11	1.17	1.11
V8	1.11	1.17	1.25	1.18
V9	1.11	1.17	1.25	1.18
MEAN	1.09	1.15	1.21	
		F-test	SEm(±)	CD at 5%
	Due to depth	S	0.03402	3.63372
	Due to site	S	0.01641	2.5911

Blocks/ Sites	0-15 cm	15-30 cm	30-45 cm	Mean
Manu (B1)				
V1	2.85	3.33	3.33	3.17
V2	2.5	3.33	3.33	3.05
V3	2.5	2.5	2.22	2.41
Ambassa (B2)				
V4	2.22	2.5	3.33	2.68
V5	2.5	3.33	3.33	3.05
V6	2.22	2.22	2.5	2.31
Salema (B3)				
V7	2.5	2.5	2.22	2.41
V8	2.85	2.85	2.5	2.73
V9	2.5	2.5	3.33	2.78
MEAN	2.52	2.78	2.89	
		F-test	SEm(±)	CD at 5%
	Dueto depth	NS	0.1136132	-
	Due to site	S	0.1047269	0.0418913

Blocks/ Sites	0-15 cm	15-30 cm	30-45 cm	Mean
	Manu(B1)			
V1	68.42	66.66	63.15	66.08
V2	65	64.7	50	59.9
V3	57.89	55.55	47.05	53.5
Ambassa (B2)				
V4	64.7	55.55	55	58.42
V5	66.66	62.5	52.94	60.7
V6	50	47.05	45.45	47.5
Salema (B3)				
V7	57.89	55.55	47.05	53.5
V8	61.11	58.82	50	56.64
V9	62.5	55.55	52.94	57
MEAN	61.57	57.99	51.51	
		F-test	SEm(±)	CD at 5%
	Due to depth	S	2.945631	3.633723
	Due to site	S	1.753611	2.591096

E. Pore space (%)

The percentage of soil pore space (Table 3) of different sites varied between 45.45 to 68.82 at the depth. The highest mean soil pore space was found at V1 – Kathalcherra (66.08 %) and the lowest mean soil pore space were found at V6 – Lalcheri (47.5%). A decrease in pore space is attributed to an increase in compaction in the soil. Similar findings have also been reported by Ray *et al*., (2016).

F. Water holding capacity (%)

Percentage of soil water holding capacity (Table 4) of different sites varied between 48.38 to 77.56 %. The highest mean soil water holding capacity was found at V1 – Karaticherra (72.06%) and the lowest mean soil water holding capacity were found at V5 – Bagmara (54.51%). In this situation, water holding capacity was high at 30-45 cm depth. These variations were due to clay, silt, and organic carbon content in soils. Similar findings have also been reported by Chaudhuri and Nath (2011).

G. Specific gravity

No significant difference was found in soil-specific gravity due to depth and sites. Specific gravity (Table 4) in soils of different sites varied between 1.66 to 2.78 which is indicative of porous particle and high organic matter content. The highest mean soil-specific gravity was found at V6 –Lacheri (2.39) and the lowest mean soil-specific gravity was found at V8 – Kochucherra (1.99). Similar findings were done by Tripura and Sarkar (2011).

Table 4: Evaluation of Water Holding Capacity and Specific Gravity of different sites of Dhalai district Tripura at 0-15 cm, 15-30 cm, and 30-45 cm.

Blocks/ Sites	0-15 cm	15-30 cm	30-45 cm	MEAN
Manu (B1)				
V1	71.53	72.16	72.5	72.06
V2	57.22	58.48	66.75	60.82
V3	60	68.82	69.52	66.11
Ambassa (B2)				
V4	72.5	68.82	60.01	67.11
V5	48.38	51.51	63.63	54.51
V6	55.45	63.12	68.82	62.46
Salema (B3)				
V7	58.38	64.66	66.66	63.23
V8	64.05	68.33	77.56	69.98
V9	70.55	70	74.1	71.55
MEAN	62.01	65.1	68.84	
		F-test	SEm(±)	CD at 5%
	Due to depth	S	1.97522	0.02197
	due to site	S	1.89871	0.005

Blocks/Sites	0-15 cm	15-30 cm	30-45 cm	MEAN
Manu (B1)				
V1	2.78	1.95	2.03	2.25
V2	2.16	2.18	2.22	2.18
V3	2.3	2.11	2.01	2.14
Ambassa (B2)				
V4	1.93	2	2.07	2
V5	2.42	2.45	2.24	2.37
V6	2.22	2.61	2.28	2.39
Salema (B3)				
V7	2.36	2.37	2.09	2.27
V8	1.66	2.22	2.1	1.99
V9	2.14	2.15	2.17	2.16
MEAN	2.22	2.23	2.13	
		F-test	SEm(±)	CD at 5%
	Due to depth	NS	0.03054	-
	Due to site	NS	0.04712	-

CONCLUSION

The soils of Dhalai might be considered to be in good physical condition. Due to the widespread adoption of organic farming in most agricultural fields, there are few variances in mean values. The soil texture is primarily Sandy clay loam, which is ideal for paddy and most other crops. The upper layer of the soil had a lighter shade, whilst the underlying layer had a darker shade. The bulk density values were extremely low and rose as the depth was raised. With depth, the particle density rose as well. Organic matter content is indicated by low specific gravity readings. High clay cohesion is indicated by good water holding capacity and pore space percentage, making Dhalai farms appropriate for paddy and a variety of other farmed crops and vegetables.

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Conflict of Interest. As a corresponding Author, I Rody Darlong, confirm that none of the others have any conflicts of interest associated with this publication.

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