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Physicochemical Properties and its Relationship with Water Holding Capacity of Roadside Tea Cultivated Soils in Dibrugarh District of Assam, India

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ABSTRACT

A study was carried out to assess the physical and chemical properties of soils and its relationship with water holding capacity (WHC) of roadside tea cultivated soils close to national highway 37 (NH 37) in the Dibrugarh district of Assam. 60 soil samples were collected from both sides of the NH at the distances of 100 m, 200 m, and 300 m, respectively. The result of the analysis showed that as the roadside distance increases from the road edge the physicochemical parameters of the soil decreases slightly in a constant pattern. The texture of the soil samples found to be sandy clay loam. The sand, silt, and clay content of soil samples varied within the ranges of 72.80±6.71-73.27±6.56, 5.02±0.37-5.18±0.48, and 21.56±6.08-22.18±6.34%, respectively. The soil pH ranged 5.20±0.08-5.36 ±0.18 and soil electrical conductivity ranged 0.31±0.07-0.34±0.08 dSm^{-1}. The total organic matter content and WHC varied from 2.64±0.72 to 3.05±0.81% and 60.72±5.26 to 63.08±5.46%, respectively. It was concluded that soil texture mainly clay fraction and total organic matter content had influenced on WHC of roadside tea cultivated soil. It was suggested that the high content of clay fraction and organic matter on soil should be incorporated to the soils with improving WHC. A significance positive relationship was observed between WHC with clay and organic matter content, while, a negative relationship was found with sand content.

Key words: *Soil texture, Total organic matter content, Water holding capacity.*

1. INTRODUCTION

Soil is the top layer of the earth's crust that performs many vital functions such as food and biomass production, storage, filtration, and transformation of many macro and micro nutrients [1]. Soil is the natural body of animal, mineral, and organic constituents differentiated into horizons of variable depth, which differ from the material below in morphology, physical makeup, chemical properties and composition, and biological characteristics [2]. Soil possesses physical, chemical, and biological properties. Physical properties such as available water holding capacity (WHC) is controlled by texture of the soil, amount of organic matter content, and structure of the soil [3]. Soil has complex function which is beneficial to human and other living organism. It acts as a filter, buffer storage, transformation system, and thus protects the global ecosystem against the adverse effects of environmental pollutants [4]. Soil is the supporting structure of plant life and water is essential to sustain plant life. Some of water is retained in the soil and some moves through the soil. It moves readily downward after an irrigation or rain and eventually reaches the ground water [5]. Textural and structural, and organic matter characteristics determine how water is held in soil [6,7]. The productivity of crops depends on the availability of soil moistures as well as nutrients status of soils. The availability of residual moisture to crops during winter season depends on the WHC of soil. The soil with small WHC will require more frequent irrigation than those with large WHC [8]. This is controlled primarily by soil texture and organic matter and other soil properties. The physical properties of a soil play an important role in determining its suitability for crop production [9]. Therefore, the present study was carried out to assess the status of physical and chemical properties and its relationship with WHC of roadside tea cultivated soils in Dibrugarh district of Assam.

2. MATERIALS AND METHODS

The study was conducted in the roadside tea cultivated soils of both sides of national highway (NH 37) from Moran to Dibrugarh in the year 2014. 60 soil samples were collected from different locations of roadside tea cultivated fields. For each sampling site (both sides of the road, NH 37), three top soil (0-20 cm) samples were collected accordingly to 100 m, 200 m, and 300 m from

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road distances. Composite soil samples were taken and prepared for necessary analysis in the laboratory [10,11]. The locations of sampling stations were determined by using global positioning system (GARMIN e-Trex 30). The texture in the present experiment was determined by the hydrometer method [12]. Organic matter was determined by the procedure [11,13]. The pH, electrical conductivity (EC), and WHC were determined by using the procedures [11].

3. RESULTS AND DISCUSSION

3.1. Soil Texture

It was observed that the roadside tea cultivated soil basically sandy clay loam type. The texture of soil samples is given in Table 1. The results show that sand dominates over clay and silt, and the values could be arranged in the ranges of sand: 72.80±6.71-73.27±6.56%, silt: 5.02±0.37-5.18±0.48%, and clay: 21.56±6.08-22.18±6.34%. Usually, clay loam soil is considered as more preferable for agricultural crops [14], but it seems that good tea production can also take place in sandy clay loam soil. Soil texture is considered an important parameters of tea cultivated soil because it influences the WHC of soil that control the flow dynamics of water, nutrients, and salts in soil. It was observed that the percentage composition of clay fraction slightly decreases with the increase of distance from the road, but sand and silt fraction slightly increases with the increase of distance from the road.

3.2. Soil pH and EC

The pH values of soil samples ranged from 5.20±0.08 to 5.36±0.18 (Table 2). It was found that all the soil samples were moderately acidic in nature. The EC of soil samples ranged from 0.31±0.07 to 0.34±0.08 dSm^{-1}.

3.3. Soil Total Organic Matter

The data showed that a large amount of organic matter was found in the tea cultivated soil (Table 2). If the organic carbon content is <0.50%, the soil is considered as low in carbon and if the same is >0.75%, the soil is considered very rich in carbon [15]. In the present study, the values of organic matter are ranges of 2.64±0.72-3.05±0.81%. All the soil samples in the study area contains sufficient amount of organic carbon. It was observed that the percentage of organic matter show a declining trend with the increases of distance from the road.

3.4. Soil WHC

The results of soil WHC (Table 2) were found to be 60.72±5.26-63.08±5.46% in the tea cultivated soil. It is found true that the soil texture will have certain influence on the WHC of soil. As the percentage of clay fraction increases in the soil, the WHC increases because clay can bind the water molecules more effectively. Thus, soils possessing high amount of clay will have enhanced WHC. Similar findings have been

Table 1: Physico-chemical analysis of roadside tea cultivated soil samples (from Moran to Dibrugarh, NH37 both sides).

Variable	Level	Range			Textural class
		Sand (%)	Silt (%)	Clay (%)	
Distance	100 m	72.80±6.71 (66.09-79.51)	5.02±0.37 (4.65-5.39)	22.18±6.34 (15.84-28.52)	Sandy clay loam
	200 m	72.94±6.61 (66.33-79.55)	5.12±0.42 (4.70-5.54)	21.94±6.19 (15.75-28.13)	Sandy clay loam
	300 m	73.26±6.56 (66.70-79.80)	5.18±0.48 (4.72-5.66)	21.56±6.08 (15.48-27.64)	Sandy clay loam

NH: National highway

Table 2: Physicochemical analysis of roadside tea cultivated soil samples (from Moran to Dibrugarh, NH37 both sides).

Variable	Level	Range			
		pH	EC (dSm-1)	TOC (%)	WHC (%)
Distance	100 m	5.36±0.18 (5.18-5.54)	0.34±0.08 (0.26-0.44)	3.05±0.81 (2.24-3.86)	63.08±5.46 (57.62-68.54)
	200 m	5.26±0.12 (5.14-5.38)	0.32±0.07 (0.25-0.39)	2.70±0.74 (1.96-3.44)	61.98±5.38 (56.60-67.36)
	300 m	5.20±0.08 (5.12-5.28)	0.31±0.07 (0.24-0.38)	2.64±0.72 (1.92-3.66)	60.72±5.26 (55.46-65.98)

NH: National highway, TOC: Total organic matter , WHC: Water holding capacity, EC: Electrical conductivity

reported previously [5,8,9]. Soils with little WHC is gradually dried out and retard the plant growth. It was also observed that as the organic matter increases the WHC of soil also increases. This clearly indicated that soil organic matter content influences the ability of soils to retain moisture. Similar result was suggested that addition of soil organic matter increases the soil WHC [5,8,9,16]. It was also observed that the percentage of WHC show a declining trend with the increases of distance from the road (Figure 1).

3.5. Relationship between Soil Texture and WHC of Soil Samples

The simple correlation coefficient (r) between soil texture and WHC of soil samples are given in Table 3. It was found that the WHC of tea cultivated soil depends upon the soil texture. As the percentage of clay of the soil sample increases, the WHC increases and on the other hand as the percentage of sand increases the WHC decreases. It was observed positive correlation between clay content and WHC (r=0.812). Similar relationship was also reported by the following researchers [5,8,9,17,18] (Figure 2).

And negative correlation was found between sand content and WHC (r=−0.788). Similar relationship was also reported by the following researchers [9,17,18].

3.6. Relationship between Soil pH and EC with WHC of Soil Samples

It was obtained positive correlation between soil pH and WHC (r=0.705) and positive correlation between EC and WHC (r=0.722) (Figures 3 and 4).

3.7. Relationship between Soil Organic Matter and WHC of Soil Samples

It was found a positive correlation between total organic matter content and WHC of the soil samples (r=0.804). Therefore, it indicates that as the organic matter increases the WHC of soil increases (Figure 5).

4. CONCLUSION

The WHC of tea cultivated soil is a one of the important parameter of soil which determines the moisture contents required for quality leaf production.

Table 3: Single correlation coefficient (r) between WHC and some relevant soil properties.

Related soil properties	Correlation coefficient	Level of significance
Soil pH versus WHC	0.705	Positive
Soil EC versus WHC	0.722	Positive
Organic matter versus WHC	0.804	Positive
Sand versus WHC	−0.788	Negative
Clay versus WHC	0.812	Positive

WHC: Water holding capacity, EC: Electrical conductivity

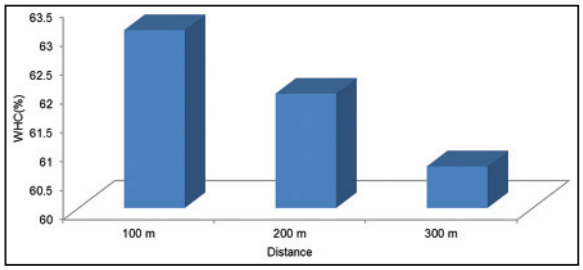

Figure 1: Water holding capacity (%) of roadside tea cultivated soil samples.

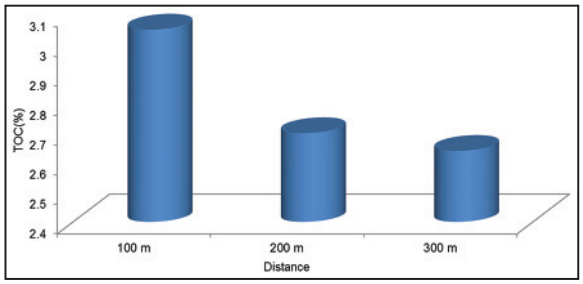

Figure 2: Total organic matter content (%) of roadside tea cultivated soil samples.

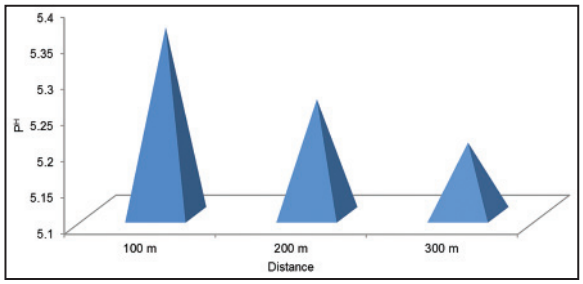

Figure 3: pH of roadside soil samples.

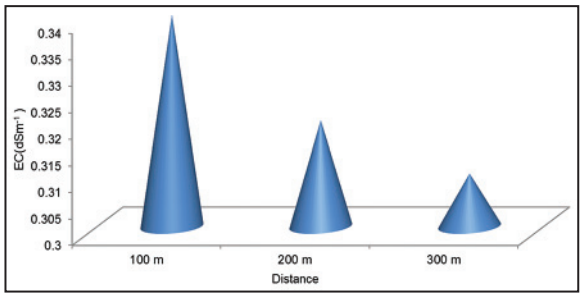

Figure 4: Electrical conductivity of roadside soil samples.

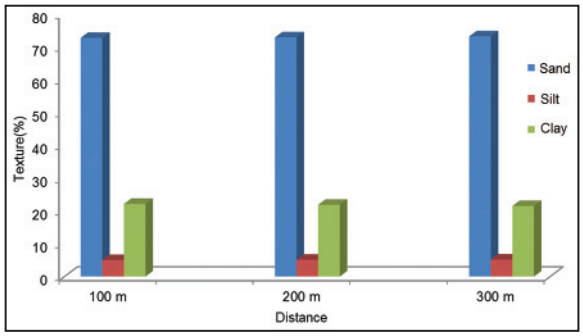

Figure 5: Texture of roadside tea cultivated soil samples.

A strong relationship exists between soil texture, soil organic matter, and soil WHC. It was concluded that the increase of soil organic matter could increase soil WHC. And also increase of soil clay fraction could increase soil WHC. Therefore, physicochemical properties of soil are the key components that control the soil WHC.

5. ACKNOWLEDGMENT

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