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Research Article

Physico-Chemical Properties and its Relationship with Soil Bulk Density of Roadside Tea Cultivated Soils in Dibrugarh District of Assam, INDIA

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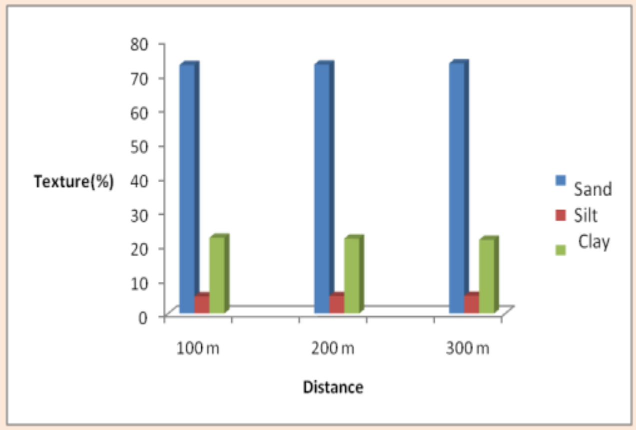
Abstract

A study was carried out to evaluate the physical and chemical properties of soils and its relationship with bulk density on roadside tea cultivated soils close to national highway (NH 37) in the Dibrugarh district of Assam. Sixty soil samples were collected from both sides of the national highway 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 physico-chemical parameters of soil except sand and bulk density 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 to 73.27 ±6.56, 5.02 ± 0.37 to 5.18 ±0.48 and 21.56 ± 6.08 to 22.18 ± 6.34 % respectively. The soil P^H ranged 5.20 ±0.08 to 5.36 ±0.18 and soil electrical conductivity ranged 0.31 ±0.07 to 0.34 ±0.08 dSm^{-1}. The total organic matter content and bulk density varied from 2.64 ± 0.72 to 3.05 ± 0.81 % and 0.985 ± 0.039 to 1.071 ± 0.047 g cm^{-3} respectively. It was concluded that soil texture mainly sand and clay fraction and total organic matter content had influenced on bulk density of roadside tea cultivated soil. It was suggested that high content of clay fraction and organic matter on soil should be incorporated to the soils with decreasing bulk density. Soil bulk density showed negative relationship with pH, electrical conductivity, clays and total organic matter content and positive relationship with sand.



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Keywords: Soil texture, total organic matter content, clay and bulk density.

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Introduction

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 make up, chemical properties, composition and biological characteristics [1]. Soils are composed of solids and pores which hold water and air. The ideal soil would hold sufficient air and water to meet the needs of plants with enough pore space for easy root penetration, while the mineral soil particles would provide physical support and plant essential nutrients. Soil bulk density is a basic soil property influenced by some soil physical and chemical properties. Bulk density is influenced by the soil texture, organic matter in soil, constituent minerals and porosity [2].

Bulk density is defined as the ratio of the mass, M of dry soil to its volume, V. It is calculated for the dried soil, moisture is not included in the sample weight. Depending upon the different soil texture, the bulk density of the soil varies. Loose and porous soils have low mass per unit volume and compact soil have high mass/volume ratio. A normal range of bulk densities for clay is 1.0 to 1.6 g cm^{-3} and a normal range for sand is 1.2 to 1.8 g cm^{-3} with potential root restriction occurring at ≥ 1.4 g cm^{-3} for clay and ≥ 1.6 g cm^{-3} for sand [3].

Soil texture refers to the sizes that make up the soil and proportion of particle sizes [4]. The relative proportion of different soil particles i.e. sand, clay and silt is known as soil texture. Soil texture is one of the most stable properties and a useful index of several other properties that determine the agricultural potential of soil. It affects the properties of soil including its water supplying power, rate of water infiltration, aeration, soil fertility, ease of tillage and susceptibility to erosion. Sandy soils are porous, have high infiltration rates, and retain little water, but clays have low infiltration rates, retain much water and may be poorly drained. Aeration is good in sandy soils but poor in clays. Roots penetrate sand more easily than clays. The fine and medium textural soils, such as the loam, clay loam, sandy clay loam, silt clay loam and sandy silt loams are generally more desirable because of their superior retention of nutrients and water [5].

Soil organic matter, the organic fraction of the soil, is a complex mixture of plant and animal products in various stages of decomposition [6]. Organic carbon influences the soil compactibility [7]. Soil organic carbon and soil organic matter maintains a ratio of 1:1.724. The presence of organic matter is of great importance in the formation and stabilization of soil structure. Organic matter within the soil serves several functions. When plant residues are returned to the soil, various organic compounds undergo decomposition. Decomposition is a biological process that includes the physical breakdown and biochemical transformation of complex organic molecules of dead material into simpler organic and inorganic molecules. Decomposition of organic matter is largely a biological process that occurs naturally. Successive decomposition of dead material and modified organic matter results in the formation of a more complex organic matter called humus [8]. Humus affects soil properties and also supplies nutrients to the soil and improves its ability to retain moisture [9]. Bulk density is influenced by amount of organic matter in soils, their texture, constituent minerals and porosity [2]. Soil organic carbon influences many soil characteristics including colour, nutrient holding capacity, nutrient turnover and stability, which in turn influence water relations, aeration and workability. Soil organic matter plays a key role in nutrient cycling and can help improve soil structure. The bulk density depends on several factors such as compaction, consolidation and amount of soil organic carbon present in the soil but it is highly correlated to the organic carbon content [10, 11]. It was found that increase in organic matter decreases the bulk density of tea cultivated soil. Therefore, it was proposed to study the physico-chemical properties and its relationship with bulk density of roadside tea cultivated soils in Dibrugarh district of Assam (India).

Materials and Methods

The study was conducted in the roadside tea cultivated soils of both sides of national highway NH37 from Moran to Dibrugarh in the year 2014. Sixty soil samples were collected from different locations of roadside tea cultivated fields. For each sampling site (both sides of road, NH37), three topsoil (0-20 cm) samples were collected accordingly to 100 m, 200 m and 300 m from road distances. Composite soil samples were taken and prepared for necessary analysis in the laboratory [12, 13]. 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 [14]. Organic matter was determined by the procedure [13, 15]. The P^H, electrical conductivity and bulk density were determined by using the procedures [13].

Result and Discussions

Soil texture

It was observed that the roadside tea cultivated soil basically sandy clay loam type. The texture of soil samples are given in **Table 1, Figure 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 to 73.27 ± 6.56 %, Silt: 5.02 ± 0.37 to 5.18 ±0.48% and Clay: 21.56 ± 6.08 to 22.18 ± 6.34 %. Usually clay loam soil is considered as more preferable for agricultural crops [5], 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 bulk density of soil that control the flow dynamics of water, nutrients and salts in soil. It was observed that 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.

Soil P^H and electrical conductivity

The pH values of soil samples ranged from 5.20 ± .08 to 5.36 ± 0.18 (**Table 2**). The variation of P^H and electrical conductivity of roadside soil samples are given in **Figures 2** and **3**. It was found that all the soil samples were moderately acidic in nature. The electrical conductivity of soil samples ranged from 0.31 ± 0.07 to 0.34 ± 0.08 dSm^{-1}.

Table1 Textural analysis of roadside tea cultivated soil samples (from Moran to Dibrugarh, NH37 both sides)

Variable	Level	Sand (%) Range	Silt (%) Range	Clay (%) Range	Textural class
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

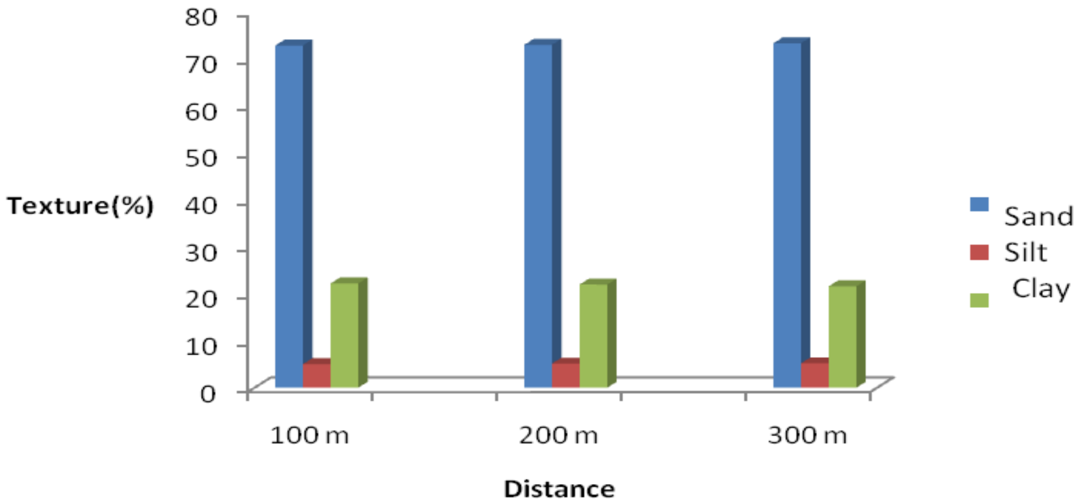

Figure 1 Variation of texture of roadside tea cultivated soil samples

Table 2 Physico-chemical analysis of roadside tea cultivated soil samples
(from Moran to Dibrugarh NH37 both sides)

Variable	Level	PH Range	EC (dSm^{-1}) Range	TOC (%) Range	BD($g\ cm^{-3}$) Range
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)	0.985±0.039 (0.946-1.024)
	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)	1.002±0.028 (0.974-1.030)
	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)	1.071±0.047 (1.024-1.118)

Soil total organic matter

The data showed that large amount of organic matter was found in the tea cultivated soil (Table 2). The variation of total organic matter content (%) of roadside tea cultivated soil samples are given in **Figure 4**. 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 [16]. In the present study, the values of organic matter are ranges of 2.64 ± 0.72 to 3.05 ± 0.81 %. All the soil samples in the study area contains sufficient amount of organic carbon. It was observed that percentage of organic matter show a declining trend with the increases of distance from the road.

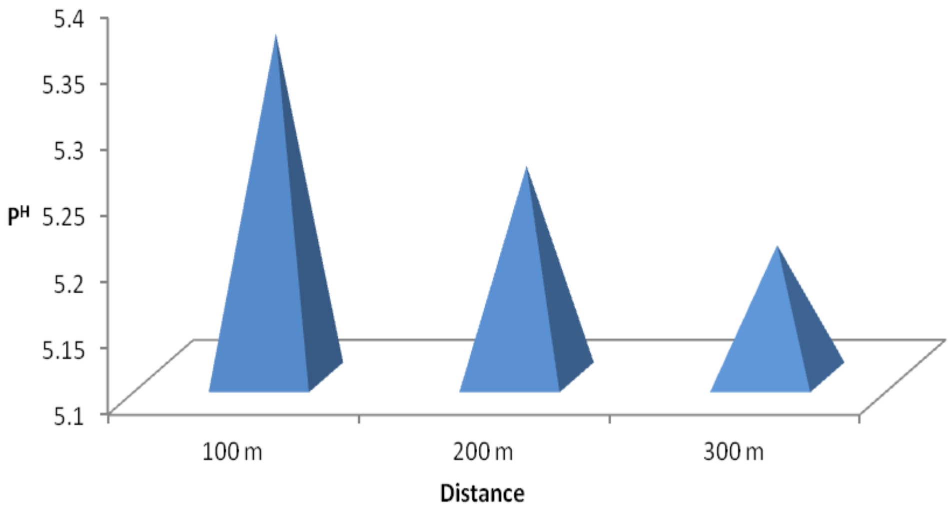

Figure 2 Variation of P^H of roadside soil samples

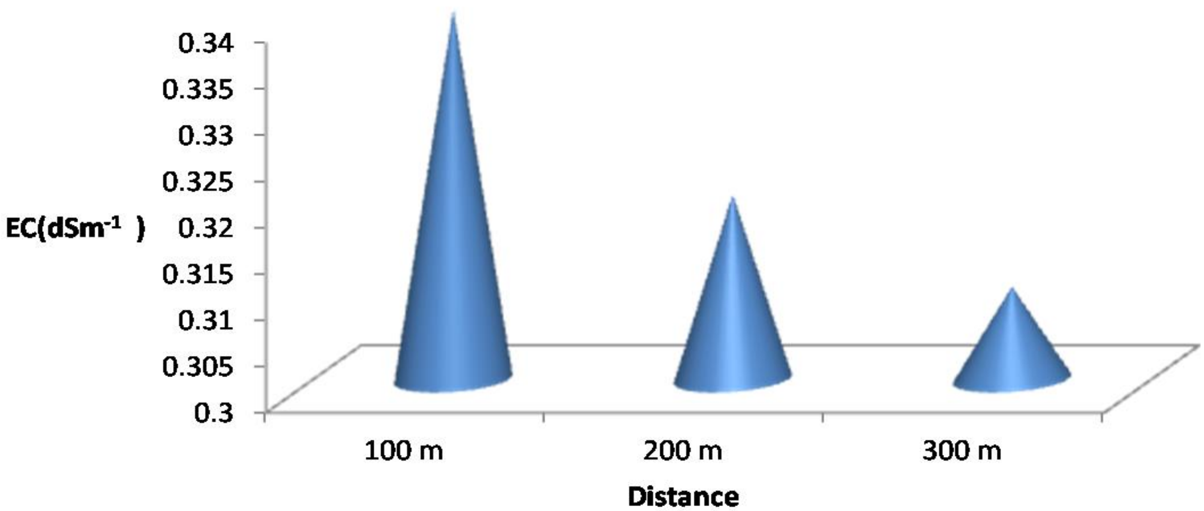

Figure 3 Variation of electrical conductivity of roadside soil samples

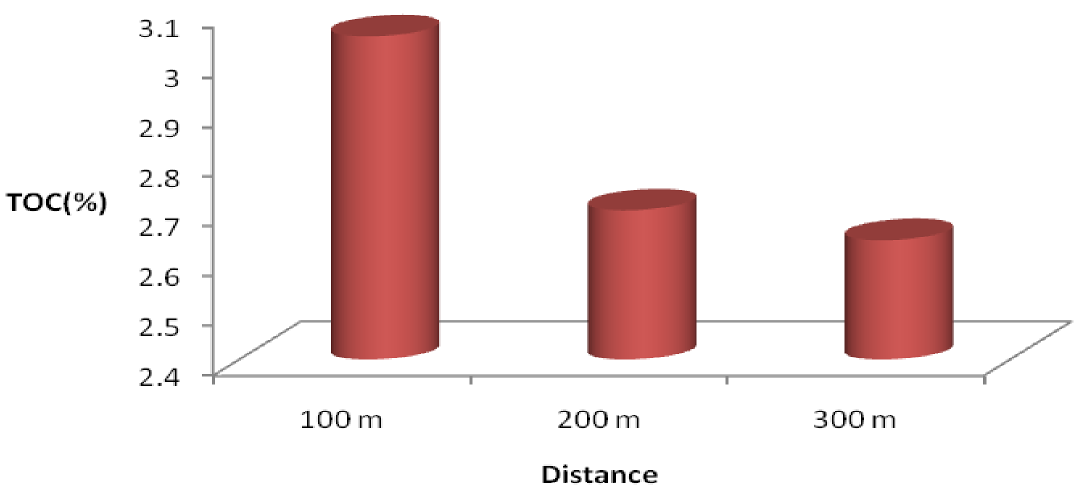

Figure 4 Variation of total organic matter content (%) of roadside tea cultivated soil samples

Soil bulk density

The results of soil bulk density were found to be 0.985± 0.039 to 1.071 ± 0.047 g cm^{-3} in the tea cultivated soil (Table 2). The variation of bulk density of roadside tea cultivated soil samples are given in **Figure 5**. It is found true that the soil texture will have certain influence on the bulk density of soil. As the percentage of sand fraction increases in the soil, the bulk density decreases. Thus, soils possessing high amount of sand will have good penetration of roots. It was also observed that as the organic matter increases the bulk density of soil also decreases. It was also observed that bulk density show an increasing trend with the increases of distance from the road.

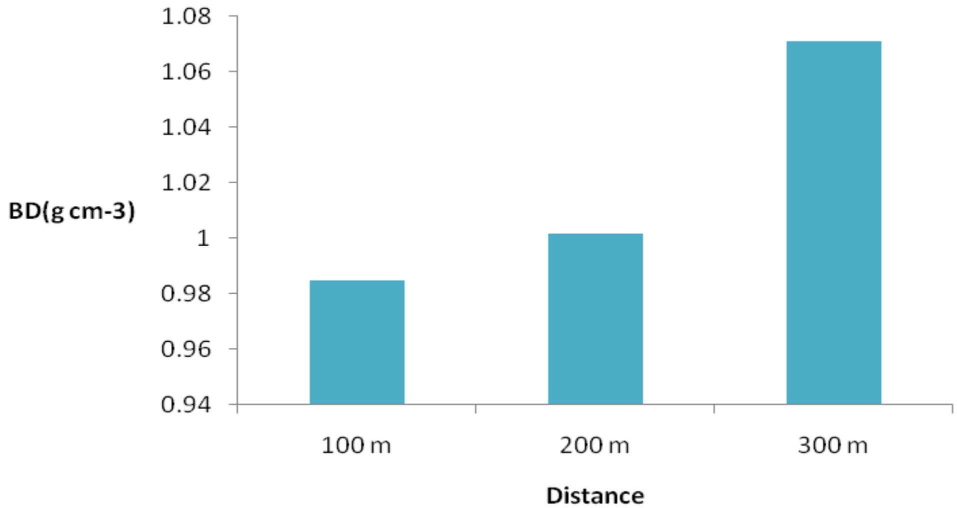

Figure 5 Variation of bulk density of roadside tea cultivated soil samples

Relationship between soil texture and bulk density of soil samples

The simple correlation coefficient (r) between soil texture and bulk density of soil samples are given in **Table 3**. It was found that the bulk density of tea cultivated soil depend upon the soil texture. As the percentage of sand of the soil sample increases the bulk density increases and on the other hand as the percentage of clay increases the bulk density decreases. It was observed positive correlation between sand content and bulk density (r=0.864). Similar relationship was also reported by the following researchers [2].

Table 3 Single correlation co-efficient (r) between bulk density and some relevant (soil properties)

	Related soil properties	Correlation Co-efficient	Level of Significance
1.	Soil pH vs BD	-0.787	Negative
2.	Soil EC vs BD	-0.747	Negative
3.	Sand & BD	0.864	Positive
4.	Clay vs BD	-0. 814	Negative
5.	Organic matter vs BD	-0.761	Negative

Relationship between soil pH and electrical conductivity with bulk density of soil samples

The simple correlation coefficient (r) between soil pH and electrical conductivity and bulk density of soil samples are given in Table 3. It was obtained negative correlation between soil pH and bulk density (r= -0.787). Similar result was reported many researchers [2]. A significance negative correlation was observed between electrical conductivity and water bulk density (r= -0.747). Similar result was reported by following researchers [2].

Relationship between soil organic matter and bulk density of soil samples

The simple correlation coefficient (r) between soil matter content and bulk density of soil samples are given in Table 3.It was found negative correlation between total organic matter content and bulk density of the soil samples (r= -0.761). Similar results were reported by many researchers [2, 10, 11, 17, 18]. Therefore, it indicates that as the organic matter increases the bulk density of soil decreases.

Conclusions

The bulk density of tea cultivated soil is one of the important parameter of soil which determines the moisture contents required for quality leaf production. A strong relationship exists between soil texture, soil organic matter and soil bulk density. It was concluded that increase in sand fraction of soil could increase soil bulk density. It was observed that increase of soil organic matter could decrease soil bulk density. And also increase of soil clay fraction could decrease soil bulk density. Therefore, physio-chemical properties of soil are the key components that control the soil bulk density.

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