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Relation of Soil Bulk Density with the Soil Carbon in the Tropical Dry Deciduous Forest of Jharkhand, India

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Abstract: ***Bulk density is an important component of the soil as it helps in understanding the health of the soil. The present study is intended at examining the relationship between bulk density, organic matter and organic carbon content in the soils of tropical dry deciduous forest of Ranchi. Twelve sites were selected and soil samples were collected from 3 depths of soil i.e. 0-30, 30-60 and 60-90 cm. Soil bulk density showed negative correlation with SOC, SOM and TC but positive correlation with inorganic carbon. It was positively significant while going down the soil profile.***

Keywords: Bulk density, soil organic matter, soil organic carbon, carbon pool, soil productivity

1. Introduction

Soils are the most important component of the global carbon cycle. Carbon stored in soil is an important part of the terrestrial carbon pool (Lal and Kimble, 1997) and soils of the world are potentially viable sinks for atmospheric carbon (Lal *et al.*, 1995; Lal, 2001).Soil organic carbon (SOC) stocks are the largest reservoirs in the world. SOC plays important role in alleviating the effects of greenhouse gases and storing, and it is necessary for enhancing soil quality, sustaining and improving food production, maintaining clean water and reducing CO_2in the atmosphere (Sakin, 2012). One of the soil properties necessary to predict the change, flow and concentration of nutrients in the soils is bulk density (Bernoux *et al*., 1998). To estimate these pools correctly, we need to determine the organic carbon contents and bulk density of the soils (Sakin, 2010).

2. Material and methods

Study site

The present study was carried out in Ranchiwhich is located on southern part of the Chota Nagpur plateau. It is located at 23°21′N 85°20′E/ 23.35°N 85.33°Eand its average elevation is651 m above sea level.Ranchi has a hilly topography and is surrounded by dense tropical forests. The forests come under the Dry peninsular Sal- Type 5B/C -IC. Total forested area of Ranchi is 22.84 % of total geographical area (ISFR, 2017). Relative humidity of the region remains low. December is the coldest month with minimum temperature of 10.3°C and May is the hottest month with maximum temperature of 37.2°C. Average annual rainfall of the district is 1375 mm and more than 80 percent precipitation received during monsoon months. From June to September the rainfall is about 1,100 mm.

Field sampling and laboratory analysis

Sampling was done from the twelve sites i.e. Chirua, Rarha, Patratu, Menhri, Pusu, Uparonki, Arahanga, Banki, Gango, Kundla, Mankidih and Chipibandhdih. Soil samples from three depths i.e. 0-30, 30-60 and 60-90 cm, were collected from each site to estimate bulk density and soil carbon. Bulk density was estimated following Allen *et al*. (1974). Soil organic carbon (SOC), inorganic carbon (IC) and total carbon was measured through combustion process (Liqui II TOC Elementar Analyser). Soil organic Matter (SOM) was obtained from estimated SOC using the conventional conversion, SOM = 1.72 × SOC (Morisada et al., 2004). Observed data was statistically analyzed by main effect ANOVA, with depth as a factor. Correlations between variables were calculated using Pearson's correlation coefficient. The statistical analysis was performed using the Statistica version 6, Statsoft. Inc. 2001, USA.

3. Results

Bulk density showed positive correlation with depth ($F= 33.46$, $p<0.001$). It was highest in the 60-90 cm depth and lowest in 0-30 cm depth (**Table 1**). The mean value of the bulk density in 0-30 cm, 30- 60 cm and 60-90 cm depth was 1.29 g cm^{-3}, 1.34 g cm^{-3} and 1.41 g cm^{-3}, respectively.It showed negative correlation with soil organic carbon, total carbon and soil organic matter but was positively correlated with the soil inorganic carbon (**Table 2).**

Table 1: Bulk density of the soil in the different depths of the sites

SITE	*0-30 cm*	*30-60 cm*	*60-90 cm*
CHIRUA	1.39 ± 0.11	1.44 ± 0.12	1.52 ± 0.1
RARHA	1.24 ± 0.13	1.20 ± 0.13	1.36 ± 0.13
PATRATU	1.20 ± 0.11	1.31 ± 0.16	1.33 ± 0.12
MENHRI	1.36 ± 0.2	1.38 ± 0.11	1.43 ± 0.14
PUSU	1.42 ± 0.23	1.45 ± 0.14	1.52 ± 0.21
UPARONKI	1.45 ± 0.18	1.54 ± 0.11	1.46 ± 0.17
ARAHANGA	1.20 ± 0.11	1.27 ± 0.12	1.39 ± 0.21
BANKI	1.19 ± 0.16	1.26 ± 0.16	1.34 ± 0.17
GANGO	1.24 ± 0.14	1.28 ± 0.21	1.40 ± 0.18
KUNDLA	1.30 ± 0.15	1.31 ± 0.23	1.41 ± 0.20
MANKIDIH	1.25 ± 0.2	1.32 ± 0.2	1.35 ± 0.26
CHIPIBANDHDIH	1.28 ± 0.16	1.36 ± 0.26	1.43 ± 0.3

*values are in g cm^{-3}, ± means SE.

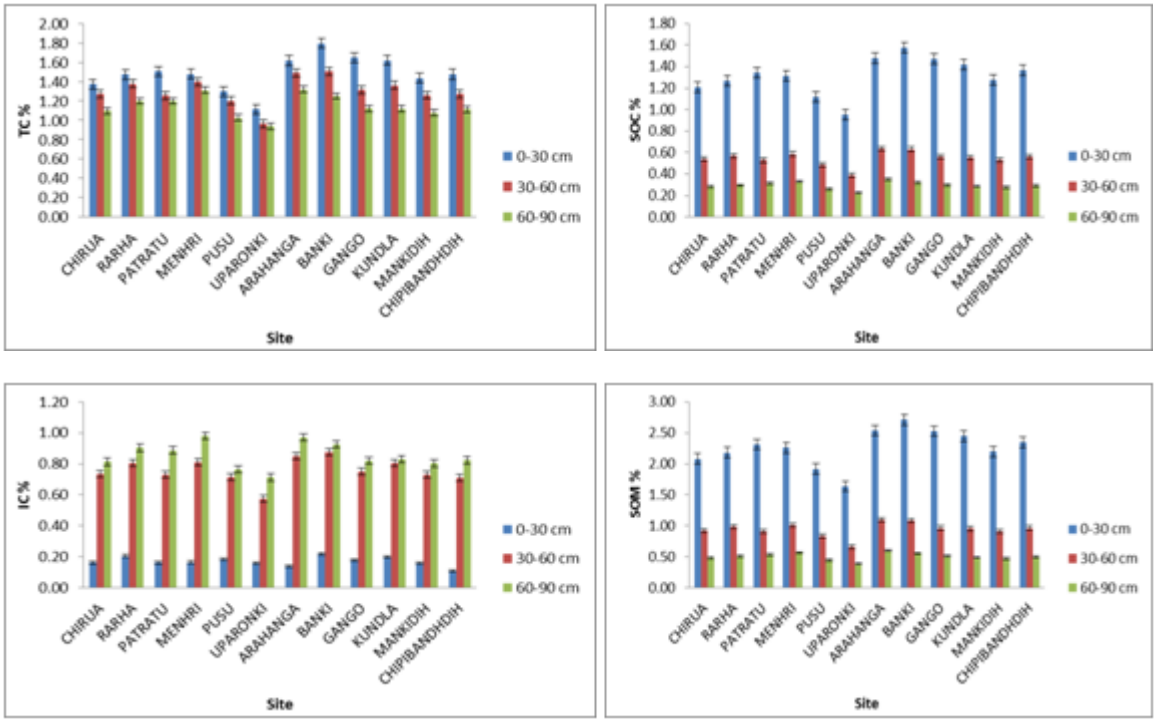


Figure 1: Total carbon (TC), soil organic carbon (SOC), inorganic carbon (IC) and soil organic matter (SOM) concentration in the soils of the studied sites at three depths.

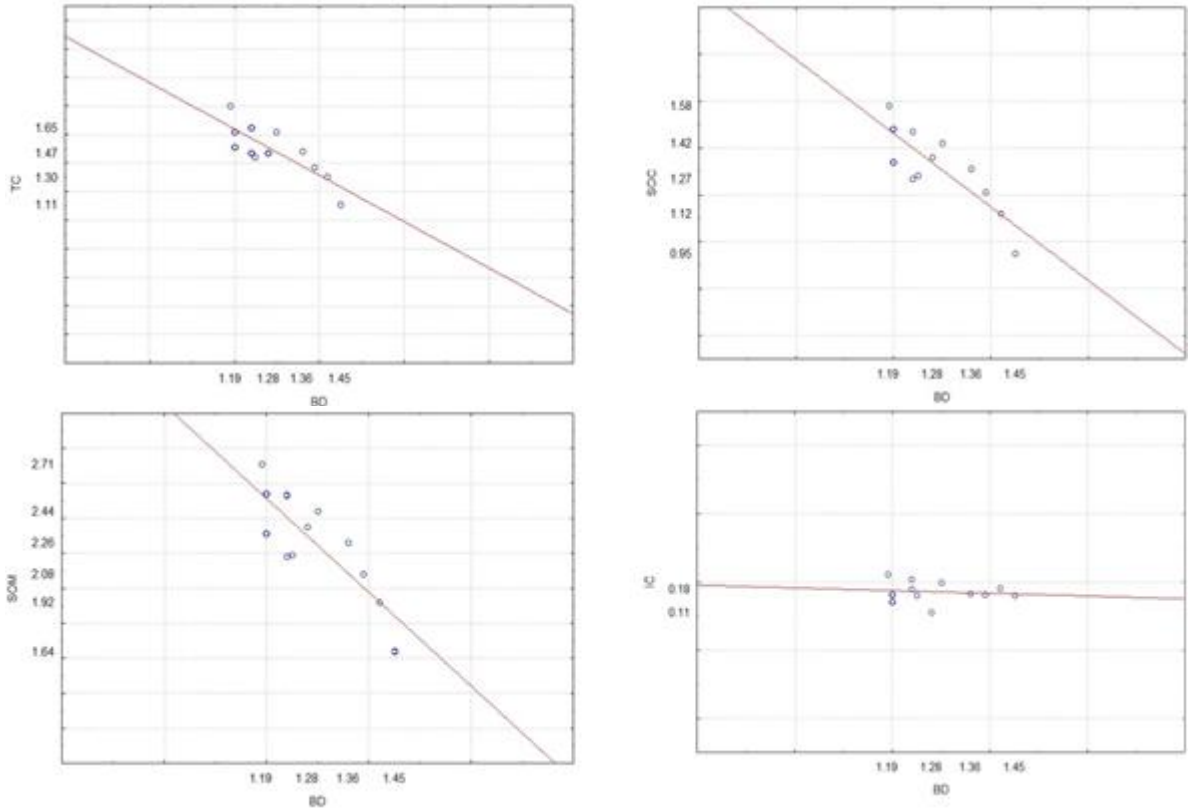


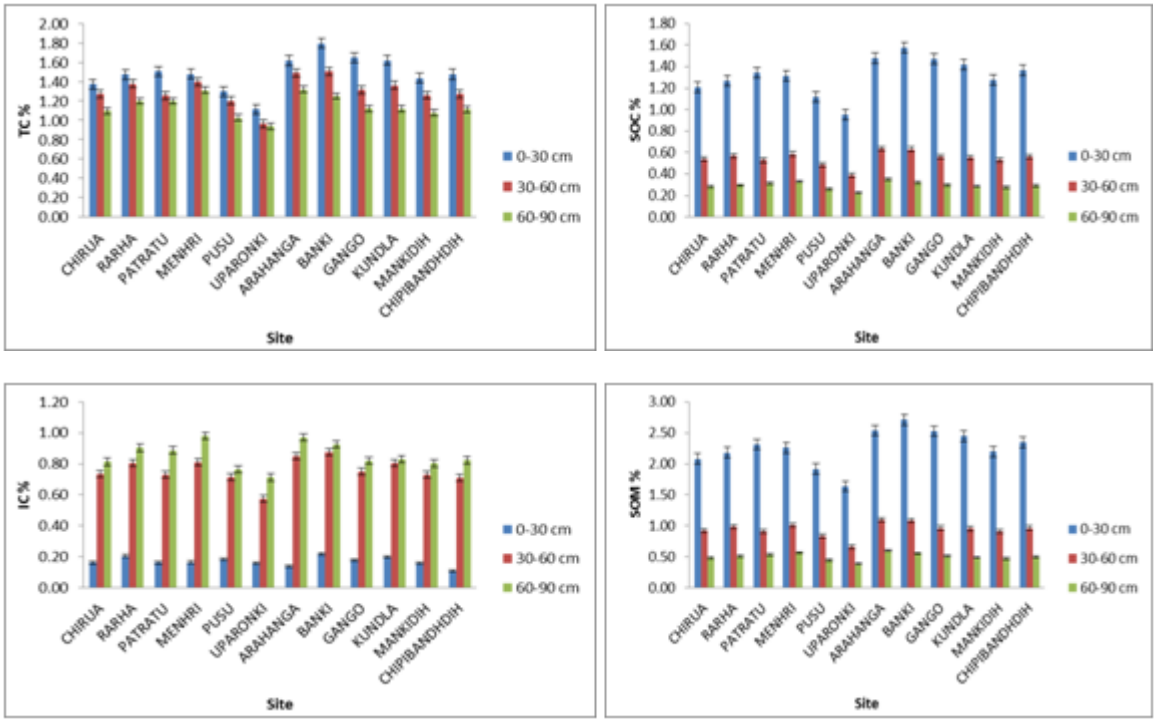
Figure 2: Correlation of bulk density with total carbon, organic carbon, soil organic matter and inorganic carbon

Table 2: Correlation between different parameters of the soil

	site	depth	BD	STC	SOC	SIC	SOM
site	1.00						
depth	0.00	1.00					
BD	-0.19	**0.51***	1.00				
STC	-0.02	**-0.67***	**-0.51***	1.00			
SOC	0.05	**-0.82***	**-0.59***	**0.96***	1.00		
SIC	-0.21	**0.86***	**0.54***	**-0.44****	**-0.68***	1.00	
SOM	0.05	**-0.82***	**-0.59***	**0.96***	**1.00**	**-0.68***	1.00

*BD- bulk density, STC- soil total carbon, SOC- soil organic carbon, SIC- soil inorganic carbon, SOM- soil organic matter.

Soil organic carbon and soil organic matter showed negative correlation with depth (F=170.22, p<0.001). Soil total carbon also showed negative correlation with depth (F= 47.11, p<0.001) but inorganic carbon had positive correlation (F= 107.11, p<0.001)



(**Figure 1**). There was a strong relationship between SOC and SOM. Perie and Ouimet (2007) also reported the similar result. Thus, the study indicates that as the SOC and SOM increases, thebulk density of soil decreases which is required for the proper growth of the trees.

4. Conclusion

So far as the soil of forests of Ranchi is concerned, thesoils were found to be less productive. There is a significantnegative correlation between organic matter and bulk density ofsoil. Soil productivity is largely a function of amount of organic matter present in the soil. It is one of the important componentsof soil and helps the soil to maintain better aeration for germinating seeds and plant rootdevelopment. All the soil samples were having low organicmatter content which means lower nutrient status and thus having low soil productivity.

References

[1] Allen, S.E., Grimshaw, H.M., Parkinson, J.A., Quarmby, C., 1974. Determination of lignin. In: Allen, S.E. (Ed.), Chemical Analysis of Ecological Materials. Blackwell, Oxford, pp. 785-799.
[2] Bernoux M, Arrouays D, Cerri C, Volkoff B, Jolivet C (1998). Bulk Densities of Brazilian Amazon Soils Related to Other Soil Properties. Reprinted from the Soil Sci. Socicfy Am. J. Volume 62, no. 3, May- June 1998 G77 South Segoe Rd. Madison. WI 5371 1 USA.
[3] ISFR (2017).Forest survey of India.
[4] Lal R and Kimble JM (1997).Conservation tillage for soil carbon sequestration.*NutrCyclAgroecosyst*49: 243-253
[5] Lal R, Kimble J, and Stewart B.A. (1995).World soils as a source or sink for radiatively-active gases. In: Lal R, and Stewart BA (eds.) Soil Management and Greenhouse Effect, pp 1-8 Lewis Publishers, Boca Raton, FL, USA 80
[6] Lal, R.(2001) . Desertification control to sequester carbon and reduce net emissions in the United States.*Arid lands Newsletter*, No. 49, May/June 2001
[7] Morisada K., Ono K. and Kanomata H. (2004). Organic Carbon Stock in Forest Soils in Japan, *Geoderma*, **(119),** 21-32.
[8] Perie C, Ouimet R (2007). Organic carbon, organic matter and bulk density relationships in boreal forest soils.*Can. J. Soil Sci*. **88**: 315- 325.
[9] Sakin, E (2010). Carbon Balance and Stocks of Soils Southeast Anatolia Region (GAP).Harran University. Graduate School of Natural and Applied Sciences Department of Soil Science. PhD Thesis, Sanliurfa.p. 234.
[10] Sakin E. (2012). Organic Carbon Organic Matter andBulk Density Relationships in Arid-Semi Arid Soils in Southeast Anatolia Region, African J. of Biotech, 11(6),1373-1377