Soil Properties under Different Land Use Systems in Karimganj District of Assam, India

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A B S T R A C T

Geo-referenced composite soil samples were collected from twelve different land use systems (LUS) of the Karimganj district of Assam. The results revealed a wide textural variation ranging from silt loam to clayey in the studied soils. Bulk density was significantly higher (1.48 Mg m^{-3}) in uncultivated LUS and lowest (1.20 Mg m^{-3}) recorded in forest. Porosity of soils ranged from 39.9% to 52.1%. pH of the soils was found to be very strongly to moderately acidic (4.81-5.78) where tea soils was recorded for significantly lowest value of pH (4.81). The organic carbon of soils was found medium to high in all LUS. Similar observation was recorded in total organic carbon. CEC of the soils ranged from 7.8 to 10.8 cmol (p+)kg^{-1}and found to be mostly regulated by clay fraction of the soils. The percent base saturation of the soils in most of the LUS varied from 30 to 40%.

Introduction

Soil, the source of infinite life is the most vital and precious natural resource, and not renewable in short time. Soil fertility refers to the ability of a soil to sustain agricultural plant growth, and result with consistent yields of high quality. Soil fertility is a dynamic natural property and it can change under the influence of natural and human induced factors. Parent material, climate, topographical conditions, natural vegetation are the natural factors affecting the soil fertility to a great extent. Among the anthropogenic factors, nutrient management practice is one of the most important factors affecting the soil fertility. Besides the natural factors and nutrient management practices, land use pattern also plays a vital role in governing the nutrient dynamics and fertility of soils (Chavan *et al.*, 1995). Land use system determines the type of vegetation and the soil management practices which in turn affect the processes of erosion, oxidation, mineralization and leaching.

According to Wang *et al.,* (2001) climate and geological history are the two important factors affecting soil properties on regional and continental scales while, land use may be the dominant factor of soil properties under small catchment scale.

Land use system affect the distribution and supply of soil nutrients by directly altering soil properties and influencing biological transformations in rooting zone. Hence, soil properties are continuously influenced by land uses with profound influence on its productivity and sustainability. Therefore, knowledge on the impact of land uses on soil property has immense importance for sustainable agricultural production and soil health maintenance. Numerous studies on the impact of land use systems on properties and fertility status of soils of both abroad and the country is appeared in the scientific literature. However, very little work has been done in this direction in Assam and more particularly in soils of Barak valley region.

Barak valley is situated between Longitude 92° 15′ and 93° 15′ East and Latitude 24° 8′ and 25° 8′ North covering an area of 6922 sq km. The Barak Valley region, which forms the southern part of the state of Assam, is comparatively smaller in size than the Brahmaputra valley. The valley is characterized by undulating topography. The hills and hillocks, locally known as tillas predominate the land surface. Karimganj district covers an area of 1839 Sq. Kms., and is situated between 24° N latitude and 92° E longitude. It is on the left Bank of the river Kushiara and is extreme southern periphery of Assam. The district is surrounded by Bangladesh and Cachar district of Assam in the north, Mizoram in the south, Bangladesh and Tripura in the west and Hailakandi district of Assam in the east. The district covers an area of 1839 Sq. Kms. which comes under Agro-Eco Sub Region, AESR 15.3 Q8A9.

Various land use systems viz. rice based, arable crop based and plantation crop based etc. are commonly prevalent in the district but little information is available on soil properties in general and impact of land use systems on soil properties in particular, the present study was thus undertaken.

Materials and Methods

Ten geo-referenced composite surface (0 – 0.25 m) soil samples from each of the dominant land use systems e.g., rice-fallow, rice-pulse, rice-oilseed, rice-vegetable, vegetable-vegetable, pulse-oilseed, uncultivated, tea, rubber, arecanut, jhum (abandoned) and forest land use systems thereby totaling one hundred twenty soil samples were collected from twelve land use systems of Karimganj district in Assam were studied. The collected soil samples were air dried in shade, grinded, mixed well and passed through a 2 mm sieve to remove stones, roots and large organic residues and then kept in polythene bags with proper labelling for subsequent laboratory analysis. Mechanical analysis of soil was done by International Pipette Method (Piper, 1966). Samples were analysed for bulk density by Clod method (Black, 1965), Particle density by Pycnometer method (Black, 1965), pH (1: 2.5 soil/water ratio), organic carbon (Walkley and Black, 1934), total organic carbon (Schumacher, 2002), electrical conductivity by Conductivity Bridge method. Soil samples were also analysed for exchangeable Al (McLean, 1965), exchangeable cations by leaching with neutral normal NH_4OAc (Barrows and Simpson, 1962), cation exchange capacity by distillation method.

Duncan's Multiple Range Test (DMRT) has been done for all the LUS to evaluate the variation of parameters among these twelve different land use systems of the district.

Results and Discussion

The physico-chemical properties of the soils under all the land use systems in Karimganj district of Assam were presented in Table 1. Clay particle showed significant variation with a range of 23.6% in rubber to 36.4% in rice-vegetable land use system. It was observed that clay content was higher in field crop based LUS than those of tree based LUS. The bulk density of the soils under these twelve land use systems varied significantly from 1.20 Mg m^{-3} in forest to 1.48 Mg m^{-3} in uncultivated LUS (Table 1). The higher mean bulk density in the uncultivated land might be due to the soil compaction, lighter texture and degradation of organic matter (Donis and Assefa, 2017). Porosity of the soils ranged significantly from 39.9% in abandoned jhum land to 52.1% in rubber plantation (Table 1). The lowest porosity (39.9%) in abandoned jhum LUS (Table 1) could be attributed to the fact that burning of forest might have degraded the soil organic matter resulting soil compaction leading to highest bulk density of the soil. This was supported by the existence of significant negative correlation (r = -0.758**) between porosity and bulk density (Table 2; Mhawish, 2015).

Soil pH measured from the fields of Karimganj district under different land use systems were found to be very strongly to moderately acidic and was significantly affected by the land use systems. It was the highest (5.78) in arecanut LUS (Table 1) which might be due to the lower organic matter content as well as absence of the effect of any acid forming fertilizers. Significant and negative relation between soil pH & organic carbon as well as with total organic carbon was observed in the present study (Table 2). In general, the organic carbon content of soils under all the land use systems was medium to high. The organic carbon and total organic carbon content in all the soils under different

land use systems ranged from 0.64% in rice-fallow & rice-oilseed LUS to 1.42% in forest land use and 0.85% in rice-oilseed to 1.98% in forest respectively (Table 1). The highest OC and TOC content in forest land could be the result of addition of organic matter by decay of leaves and the lowest OC & TOC in cultivated lands like rice-fallow, rice-oilseed could be due to continuous cultivation that aggravated OC oxidation (Dawit *et al.*, 2002). The significantly highest value [10.8 cmol(p+)kg^{-1}] of CEC was noticed in forest LUS might be due to the high quantity of organic matter content in forest soil (Table 1). The per cent base saturation of the soils in all land use system varied from 15.60% in tea plantation to 45.96% in arecanut land use system (Table 1). Significantly highest and lowest PBS in arecanut and tea LUS could be attributed to the highest and lowest pH in respective land use systems that was supported by the positive significant correlation (r = 0.458**, Table 2) between PBS & pH (Dutta and Zaman, 2013; Dutta *et al.*, 2017).

The present study revealed a picture on the influence of different land use systems on the physico-chemical properties of the soils of Karimganj district of Assam. It has been observed that forest and abandoned jhum land exhibited better status in most of the soil parameters than the other land use system. The mean bulk density values of the studied soils were found higher in uncultivated LUS indicated more soil compaction in uncultivated LUS resulting unfavourable soil condition. Moreover, Percent Base Saturation was also significantly low in soils under tea, rubber and uncultivated LUS. Considering the forest land as benchmark, the inferiority of soils under agricultural activity is visible in the present investigation. Thus, initiation of judicious and location specific soil management practices becomes an important step in order to maintain the soil health in a sustainable basis.

Table.1 Distinguished physico-chemical properties of soils under different land use systems in Karimganj district of Assam

Land Use Systems	Clay (%)	Bulk Density (Mg m^{-3})	Porosity (%)	pH	OC (%)	TOC (%)	CEC [cmol(p+)kg^{-1}]	PBS (%)
Rice-fallow	36.1^a	1.24^{de}	46.6^{bcd}	5.33^{bc}	0.64^e	0.87^e	10.3^{ab}	34.08^c
Rice-pulse	36.3^a	1.32^{bc}	45.3^d	5.71^a	0.69^{de}	0.93^e	9.9^{bc}	39.28^b
Rice-oilseed	35.3^{ab}	1.24^{de}	49.0^{abc}	5.67^a	0.64^e	0.85^e	9.8^{bc}	40.22^b
Rice-vegetable	36.4^a	1.22^{de}	49.2^{abc}	5.53^{ab}	0.80^d	1.11^d	10.6^{ab}	32.03^c
Vegetable-vegetable	33.3^{abc}	1.28^{cd}	49.2^{abc}	5.53^{ab}	0.72^{de}	1.01^{de}	9.0^c	35.61^c
Pulse-oilseed	31.8^{bcd}	1.31^{bc}	49.8^{ab}	5.38^{bc}	0.75^{de}	1.02^{de}	9.8^{bc}	34.70^c
Uncultivated	29.4^{cd}	1.48^a	41.3^e	5.72^a	0.69^{de}	0.94^{de}	9.7^{bc}	28.29^d
Tea	30.6^{cd}	1.24^{de}	51.4^a	4.81^e	1.22^b	1.70^b	7.8^d	15.60^e
Rubber	23.6^f	1.24^{de}	52.1^a	5.11^{cd}	1.02^c	1.41^c	8.1^d	18.44^e
Arecanut	28.2^{de}	1.36^b	48.8^{abcd}	5.78^a	0.70^{de}	0.98^{de}	9.2^c	45.96^a
Abandoned jhum	30.3^{cd}	1.36^b	39.9^e	4.99^{de}	1.29^b	1.80^b	9.8^{bc}	32.81^c
Forest	24.8^{ef}	1.20^e	45.8^{cd}	4.91^{de}	1.42^a	1.98^a	10.8^a	40.95^b
LSD$_{(0.05)}$	3.9	0.056	3.283	0.262	0.112	0.156	0.845	3.593
SEm ($\pm$)	1.39	0.02	1.17	0.093	0.04	0.056	0.301	1.28
CV (%)	14.03	5.07	7.81	5.51	14.51	14.48	9.96	12.21

Means followed by the same letter in a column are not significantly different at 5% level of significance as determined by DMRT

Table.2 Correlation coefficients (r) among physico-chemical properties under different land use systems
in Karimganj district of Assam

	Sand	Silt	Clay	BD	Porosity	pH	OC	TOC	TEC	CEC	PBS
Sand	1										
Silt	-0.896**	1									
Clay	-0.154	-0.300**	1								
BD	0.590**	-0.389**	-0.401**	1							
Porosity	-0.345**	0.154	0.400**	-0.758**	1						
pH	0.245*	-0.270**	0.075	0.375**	-0.194	1					
OC	-0.016	0.145	-0.288**	-0.253*	0.004	-0.748**	1				
TOC	-0.012	0.141	-0.289**	-0.253*	0.009	-0.749**	0.999**	1			
TEC	-0.006	-0.112	0.264**	-0.068	-0.130	0.353**	-0.154	-0.160	1		
CEC	-0.192	-0.0008	0.415**	-0.222*	-0.042	0.029	0.037	0.030	0.633**	1	
PBS	0.116	-0.178	0.148	0.077	-0.181	0.458**	-0.261**	-0.264**	0.923**	0.306**	1

*Significant at 5% level of significance
** Significant at 1% level of significance

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