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ASSESSMENT OF ORGANIC CARBON BUILDUP UNDER DIFFERENT LAND USE SYSTEMS

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ABSTRACT

The present study was conducted at Professor Jayashankar Telangana Agricultural University, Rajendranagar, Hyderabad, Telangana. Soil samples were collected from 0-20 cm, 20-40 cm and 40-60 cm depth under different land use systems viz., block plantations of ficus, teak, Indian blackwood, jamun, karanja, simaruba, bamboo, neem, eucalyptus and barren land. Among all the land use systems studied soil pH was slightly acidic to neutral and varied between 6.13 to 7.17. The electrical conductivity values ranged from 0.31 to 0.51 dS m^{-1} (non-saline). In all the land use systems studied soil available organic carbon content decreased with increase in depth. Significantly higher soil organic carbon was recorded in bamboo plantation (7.01 g kg^{-1}) compared to all other land use systems. The higher bulk density (1.42 Mg m^{-3}) and lower organic carbon content (2.51 g kg^{-1}) in barren land might be due to expose of soil surface without any cultivation, which tends to lower the organic matter content. A negative correlation (r = -0.987**) was observed between soil organic carbon and bulk density. High organic carbon content in bamboo plantation might be due to high vegetative growth, fast root proliferation and organic matter breakdown. Cultivation of trees with fast growing nature in farm lands will improve the soil organic carbon through leaf litter fall, which in turn improves the soil physical and chemical properties over the years.
Keywords: Land use system, soil depth, interaction, soil organic carbon

Introduction

Agroforestry systems have been widely recognized for their effectiveness in soil conservation. The integration of trees into agricultural landscapes can significantly reduce the velocity of surface runoff, thereby minimizing soil erosion. The root systems of trees and shrubs play a crucial role in stabilizing soil and improving its structure (Reubens *et al.*, 2007). The impact of agroforestry on soil fertility and nutrient cycling is multifaceted. Trees in agroforestry systems contribute to enhanced nutrient cycling through leaf litter and root decay, which replenish soil nutrients.

Soils have the ability to store carbon for long periods, making changes in the soil carbon pool highly influential on atmospheric CO_2 levels. Maintaining adequate soil organic carbon (SOC) is essential for reducing erosion and degradation risks, retaining water and nutrients, and improving soil structure (Lal, 2004). Land use system affect the distribution and supply of soil nutrients by directly altering soil properties. The productivity and sustainability of soil depends on dynamic equilibrium among its physical, chemical and biological properties (Somasundaram *et al.*, 2013). These properties are continuously influenced by land uses. Adoption of appropriate land use management practices and land use planning would help to minimize the degradation in soil physical quality and would ensure sustainable crop production and productivity (Ramesh *et al.*, 2008). In view of the importance of tree-based land use systems in soil conservation, the present study was taken up to know the best tree-based land use systems in improving soil organic carbon with reference to barren land.

Materials and Methods

The present research was carried out during the year 2024 in different land use systems i.e., block plantations of ficus, teak, Indian blackwood, jamun, karanja, simaruba, bamboo, neem, eucalyptus and barren land at Professor Jayashankar Telangana Agricultural University, Rajendranagar, Hyderabad, Telangana. The climate of this region is semi-arid tropics. A total of 90 soil samples were collected from different land uses in three depths (0-20 cm, 20-40 cm and 40-60 cm). The samples collected were shade dried, processed and sieved for further analysis.

The soil parameters were analysed using standard methods viz., Bulk density was determined by core sampler method (Blake and Hartge, 1986). The soil pH and EC were measured using 1:2.5 soil water suspension and the EC results were expressed in dS m^{-1} at 25^{o}C (Jackson, 1973). Available organic carbon by wet oxidation method given by Walkley and Black (1934).

Results and Discussion

Effect of land use systems on soil properties

Bulk density (Mg m^{-3})

Soil bulk density under different land use systems was presented in Table 1.

Significantly higher content of soil bulk density was observed in barren land (1.42 Mg m^{-3}) over all the other land use systems. The lower content of bulk density was observed in bamboo plantation (1.29 Mg m^{-3}), which was significantly lower than all other tree-based land use systems. Among all the land use systems, soil bulk density significantly increased from surface (0-20 cm: 1.32 Mg m^{-3}) to subsurface soil layers (20-40 cm: 1.34 Mg $m^{-3}$and 40-60 cm: 1.36 Mg m^{-3}) due to the decrease in soil organic carbon content from surface to subsurface layers. There was no interaction found between the land use systems and soil depth.

Lower bulk density under tree-based land use system than barren land was due to the accumulation of organic matter through litter fall, which further increases the soil particles aggregation and pore space (Singh *et al.*, 2021).

Table 1 : Effect of different land use systems on soil Bulk density (Mg m^{-3}) at three depths

Land use systems	**0-20 cm**	**20-40 cm**	**40-60 cm**	**Mean (LUS)**
Bamboo	1.27	1.29	1.30	**1.29**
Pongamia	1.29	1.31	1.33	**1.31**
Neem	1.30	1.32	1.33	**1.32**
Indian blackwood	1.31	1.33	1.34	**1.32**
Teak	1.36	1.38	1.40	**1.38**
Jamun	1.33	1.35	1.37	**1.35**
Ficus	1.28	1.30	1.31	**1.30**
simaruba	1.32	1.34	1.36	**1.34**
Eucalyptus	1.35	1.37	1.39	**1.37**
Barrenland	1.40	1.42	1.45	**1.42**
Mean (Depth)	**1.32**	**1.34**	**1.36**	
	S.Em ±	**CD (5%)**		
LUS	0.008	0.02		
depth	0.004	0.01		
LUS X depth	0.013	NS		

Soil pH

Soil pH under different land use systems was represented in Table 2.

Soil pH values under different land use systems with mean values ranged from 6.13–7.17 indicating slightly acidic to neutral in nature. The pH under different tree-based land use systems was significantly lower when compared to barren land in all the soil depths. The higher content of organic matter from decomposition under tree species might have released various organic acids contributing to the lowering of soil pH (Singh *et al.*, 2021). Among all the land use systems soil pH increased from surface soil (0-20 cm: 6.53) to subsurface soil layers (20-40 cm 6.71 and 40-60 cm: 6.88), this is due to decrease of organic matter from surface to sub-surface layers. These results are in conformity with Apoorva *et al*. (2022) and Geetha *et al*. (2021). There was no interaction found between the land use systems and soil depth.

Table 2 : Effect of different land use systems on soil pH at three depths

Land use systems	**0-20 cm**	**20-40 cm**	**40-60 cm**	**Mean (LUS)**
Bamboo	5.92	6.15	6.30	**6.13**
Pongamia	6.27	6.48	6.63	**6.46**
Neem	6.53	6.73	6.97	**6.74**
Indian blackwood	6.64	6.82	7.02	**6.82**
Teak	6.73	6.91	7.06	**6.90**
Jamun	6.65	6.76	6.92	**6.78**
Ficus	6.27	6.48	6.53	**6.42**
simaruba	6.63	6.80	7.04	**6.82**
Eucalyptus	7.02	7.18	7.32	**7.17**
Barrenland	6.65	6.76	7.01	**6.81**
Mean (Depth)	**6.53**	**6.71**	**6.88**	
	S.Em ±	**CD (5%)**		
LUS	0.03	0.08		
depth	0.02	0.04		
LUS X depth	0.05	NS		

Electrical conductivity (dS m^{-1})

Soil electrical conductivity (EC) under different land use systems was presented in Table 3.

EC values under different land use systems with mean values varied from 0.31 to 0.51 dS m^{-1} indicating non-saline nature of soil. Soil EC decreased from surface soil (0-20 cm: 0.39 dS m^{-1}) to subsurface layers (20-40 cm: 0.37 dS m^{-1} and 40-60 cm: 0.35 dS m^{-1}) among all land use systems. Significantly higher EC was found under barren land (0.51 dS m^{-1}) and lower EC values was found under tree-based land use systems (0.31 dS m^{-1} to 0.39 dS m^{-1}), which was significantly lower than all the other land use systems. These results were in accordance with Tufa *et al*. (2019). Interaction between soil depth and land use systems was found to be non- significant.

Table 2 : Effect of different land use systems on soil EC at three depths

Land use systems	**0-20 cm**	**20-40 cm**	**40-60 cm**	**Mean (LUS)**
Bamboo	0.38	0.36	0.35	**0.36**
Pongamia	0.41	0.39	0.36	**0.39**
Neem	0.40	0.38	0.35	**0.38**
Indian blackwood	0.40	0.39	0.37	**0.39**
Teak	0.33	0.32	0.29	**0.31**
Jamun	0.35	0.32	0.31	**0.33**
Ficus	0.36	0.34	0.32	**0.34**
simaruba	0.36	0.35	0.34	**0.35**
Eucalyptus	0.35	0.32	0.31	**0.33**
Barrenland	0.54	0.52	0.49	**0.51**
Mean (Depth)	**0.39**	**0.37**	**0.35**	
	S.Em ±	**CD (5%)**		
LUS	0.014	0.04		
depth	0.008	0.02		
LUS X depth	0.025	NS		

Organic carbon (g kg^{-1})

Soil organic carbon under different land use systems is presented in table.4.

The soil organic carbon content was significantly affected by different land use systems. The mean values of SOC ranged from 2.52 g kg^{-1} in barren land to 7.15 g kg^{-1} in bamboo plantation. Among all the land use systems, soil organic carbon with mean values decreased from surface soil (0-20 cm: 6.48 g kg^{-1}) to subsurface soil layers (20-40 cm: 5.41 g kg^{-1} and 40-60 cm: 3.64 g kg^{-1}). Interaction between soil depth and land use system for available soil organic carbon was found to be significant. Significantly higher amount of available soil organic carbon was observed in bamboo 8.93 g kg^{-1} at surface soil (0-20 cm) depth over all the other land use systems at all depths. Change in available soil organic carbon in soils was observed due to varying level of leaf litter and their decomposition rate (Ray *et al*., 2006). Similar results were also reported by Maini *et al*. (2020).

Table 5 : Effect of different land use systems on on soil organic carbon (g kg^{-1}) at three depths

Land use systems	**0-20 cm**	**20-40 cm**	**40-60 cm**	**Mean (LUS)**
Bamboo	8.93	6.87	5.23	**7.01**
Pongamia	7.92	6.75	4.74	**6.47**
Neem	7.07	6.34	4.66	**6.02**
Indian blackwood	6.81	4.80	3.25	**4.95**
Teak	5.30	3.93	2.23	**3.82**
Jamun	6.41	4.38	2.87	**4.55**
Ficus	8.71	6.58	4.55	**6.62**
simaruba	6.63	3.72	2.73	**4.36**
Eucalyptus	5.73	4.77	3.20	**4.57**
Barrenland	3.11	2.51	1.91	**2.51**
Mean (Depth)	**6.66**	**5.07**	**3.54**	
	S.Em ±	**CD (5%)**		
LUS	0.05	0.15		
depth	0.03	0.08		
LUS X depth	0.09	0.26		

Conclusion

This study revealed that the organic carbon buildup was higher under tree-based land use systems over barren land due to accumulation of organic matter through leaf litter and tree root growth in soil. The soil organic carbon under tree-based land use systems is in the following order: bamboo > ficus > pongamia > neem > Indian blackwood > eucalyptus > jamun > simaruba > teak. Bamboo plantation recorded higher amount of soil organic carbon due to its fast-growing nature and continuous addition of organic matter. From the results, it can be concluded that tree-based land use systems are inclusion of trees in farm lands will increase the organic carbon which in turn improves the soil physical and chemical properties. The results of this study help in developing future plans for sustainable land management strategies aimed at enhancing carbon sequestration and soil health.

References

Apoorva, M.R., Padmaja, G., Sharma, S.H.K., Triveni, S and Bhanu, R.K. (2022). Soil characteristics, microbial biomass carbon and nitrogen under different land use patterns in red soils of Vikarabad district. *Journal of Research*, PJTSAU. **50**(1), 63-69.

Blacke, G.R and Hartge, K.H. (1986). Bulk density. Methods of Soil Analysis: Physical and Mineralogical Methods. *American Society of Agronomy*, 363-375.

Geetha, K., Chaitanya, T., Padmaja, G and Krishna, A. (2021). Effect of different land use systems on soil properties. *The Pharma Innovation Journal*.**10**, 1-6.

Jackson, M.L. (1973). Soil chemical analysis. Prentice Hall India Pvt. Ltd., New Delhi. 498.

Lal, R. (2004). Soil carbon sequestration to mitigate climate change. *Geoderma*.**123** (2), 1-22.

Maini, A., Sharma, V and Sharma, S. (2020). Assessment of soil carbon and biochemical indicators of soil quality under rainfed land use systems in North Eastern region of Punjab, India. *Carbon Management*. **11**(2), 169-182.

Ramesh, V., Balloli, S.S., Sharma, K.L., Ramachandran, K., Korwar, G.R and Ramakrishna, Y.S. (2008). Characterization of soil for physical properties under different land use systems. *Indian Journal of Dryland Agricultural Research and Development*. **23**(1), 102-109.

Ray, R., Mukhopadhyay, K and Biswas, P. (2006). Soil aggregation and its relationship with physico–chemical properties under various land use systems. *Indian Journal of Soil Conservation*. **34**, 28–32.

Reubens, B., Poesen, J., Danjon, F., Geudens, G and Muys, B. (2007). The role of fine and coarse roots in shallow slope stability and soil erosion control with a focus on root system architecture: A review. *Trees*. **21**(4), 385-402.

Singh, B., Singh, S and Chaudhary, S. (2021). Physico-chemical properties and fractions of organic carbon and nitrogen in the soil under twenty-year-old tree species. *Indian Journal of Agroforestry*. **23**(2).

Somasundaram, J., Singh, R.K., Parandiyal, A.K., Ali, S., Chauhan, V., Sinha, N.K., Lakaria, B.L., Saha, R., Chaudhary, R.S., Coumar, M.V and Singh, R.K (2013). Soil properties under different land use systems in parts of Chambal region of Rajasthan. *Journal of Agricultural Physics*. **13**(2), 139-147.

Tufa, M., Melese, A and Tena, W. (2019). Effects of land use types on selected soil physical and chemical properties: The case of Kuyu District, Ethiopia. *Eurasian journal of soil science*, **8**(2), 94-109.

Walkley, A and Black, C.A. (1934). Estimation of organic carbon by chromic acid titration method. *Soil Science*, **37**, 29-38.