Research Paper

Volume : 4 | Issue : 2 | February 2015 • ISSN No 2277 - 8179

EFFECT OF MULTIPURPOSE TREE SYSTEMS ON ACCUMULATION OF ORGANIC CARBON AND MICRO NUTRIENTS IN SOILS OF ANGRAU

AGRONOMY

KEYWORDS : Organic carbon, micronutrients

R. Shankar	Department of Agronomy, College of agriculture Acharya N.G Ranga Agricultural University, Rajendranagar, Hyderabad, Andhra Pradesh
G. Srishilam	Department of physiology, College of agriculture Acharya N.G Ranga Agricultural University, Rajendranagar, Hyderabad, Andhra Pradesh
D. Naresh	Department of Agronomy, College of agriculture Acharya N.G Ranga Agricultural University, Rajendranagar, Hyderabad, Andhra Pradesh
B.Joseph	Department of farm forestry, College of agriculture Acharya N.G Ranga Agricultural University, Rajendranagar, Hyderabad, Andhra Pradesh
K.B. Sunitha Devi	Department of Agronomy, College of agriculture Acharya N.G Ranga Agricultural University, Rajendranagar, Hyderabad, Andhra Pradesh

ABSTRACT

The present investigation was carried out in Acharya N.G Ranga Agricultural University, Rajendranagar, Hyderabad, Andhra Pradesh aimed to analyze the role of multipurpose tree systems in improving soil organic carbon and micronutrient availability. Soil samples were taken for micronutrients at three depths i.e. 0-30, 30-60 and 60-90 cm. The results revealed that under the different multipurpose tree system higher accumulation of organic carbon was observed in Pongamia pinnata (0.57 to 0.29%) and lower in fallow land (0.09 to 0.08%) at different depths. Among the different micronutrients, Acacia nilotica tree system recorded the higher zinc, iron and cupper content were 1.32, 5.84 and 1.67 mg kg-1 respectively.

INTRODUCTION

Increasing industrial growth, change in land use patterns increase atmospheric pressure, deforestation and rise in fossil fuel emission have increased carbon dioxide concentration in the atmosphere which has to global warming. Trees offer a significant potential to sequester substantial quantity of atmospheric carbon. Thus forming an important option for carbon mitigation in climate. An Agroforesty system is one of the main sinks of carbon on earth in comparison to other land use system. Density of soil organic carbon is different ecosystems varies as low as 3.7 kg m^{-3} in arid to 24.0 kg m^{-3} in boreal region (Lal and Mcsweeny, 2001). The tree residues (leaf, twigs, dead plant parts) affects the organic matter and nutrient dynamics of soils by their decomposition in soils. The quality and quantity of tree residue produced depends on tree species, its genetic nature (deciduas or evergreen), age and its existed climatic conditions. The magnitude of total leaf and litter fall in different types of forest tree species of India ranged between 1585-17578 kg ha^{-1} ya^{-1} in plantations situated in different parts of country (Shanmughavel and Francis, 1998). The mean annual litter fall (kg^{-1} ha^{-1}) for tropical dry deciduas, tropical, dry evergreen and temperate moist deciduas forest are reported as 4.33, 7.52, 6.44 and 8.39 respectively (Dadwal *et al.,* 1993). Major multipurpose agroforestry systems including *Acacia nilotica, Azadirachta indica, Dalbergia sisso, Eucalyptus tetranicus, Albizia lebbeck, Pongamia pinnata* and *Tectona grandis.* However information on the effect of these species on soil properties is lacking. Therefore the present study was conducted on concentration of organic carbon, macro and micro nutrient and their accumulation in the soil profile in ANGRAU campus.

MATERIALS AND METHODS

The investigation was carried out in university campus Acharya N G Ranga Agricultural University, Hyderabad (AP) which is located altitude of 542.6 m above MSL and 17°19'N latitude. The climate is mainly characterized by a very hot summer, a short rainy season and a very cold winter, it is arid which high variation between summer and winter temperature. The mean monthly maximum temperature varies from 31.5°C to 33.3°C in January to June. Rain fall is primarily from south west monsoon and mean rain fall (>75%) of the total 788.2 mm per annually received during July to September. The soils of region are light in colour and most of the soils are alfisols some pocket of vertisols have salinity associated with brackish ground water. An experiment having 10-30 years old: *Acacia nilotica*, *Azadirachta indica*, *Dalbergia sisso*, *Eucalyptus tetranicus*, *Albizia lebbeck*, *Pongamia pinnata* and *Tectona grandis* spacing 4x4 m was selected. Soil samples were taken for organic carbon at three depths i.e. 0-30, 30-60 and 60-90 cm and 0-30 cm for micro nutrients. The soil samples were air dried, grounded in a wooden pestle with mortar passed through a 2 mm stainless steel sieve and stored organic carbon (OC), available macro (N,P,K) and micro nutrients (Zn,Fe and Cu). organic carbon by walkley and black's method (Jackson, 1967), available P_2O_5 by olsen's method using colorimeter (Olsen *et al.,* 1954), available micronutrients were extracted with DTPA extract (Lindsay and Norvell, 1978) or an atomatic absorption spectrometer. The accumulation of organic carbon (%) and available nutrients (kg ha^{-1}) in different soil layers was calculated by multiplied their concentration values with the weight of soil depth in hectare. The date of different species were subjected to statical analysis using ANOVA technique in RBD by taking 6 replications of locations and treatment as tree species mean separation was done with the critical difference value of 5% significance (Panes and Sukhatme, 1985).

RESULTS AND DISCUSSION

Among the land use systems higher organic carbon content (0-30 cm) recorded in *Pongamia pinnata* (0.57%) followed by *Albergia lebbeck* (0.47%), *Tectona grandis* (0.30%), *Acacia nilotica* (0.26%), *Eucalyptus tereticornis* (0.25%), *Dalbergia sisso* (0.20%) and lower in *Azadiracta indica* (0.09%) (Table.1). The soil organic carbon accumulation in 60-90 cm on soil profile under the tree species varied from 0.29% under *Pongamia pinnata* to 0.25% under *Albergia lebbeck* and this content was significantly higher than control treatment 0.08% and showed less variation. Out of this, >42% of profile organic carbon was present in the surface layer of 0-30 cm and >21% in 30-60 cm soil depth under different tree species, indicating >40 in upper soil layers in a span of 20 years. High leaf litter falling rate, high decomposition rates lower C: N ratio of plant parts increased the organic matter content under soils of *Pongamia pinnata*. It similar results obtained by Kavvadias *et al.* (2001) and Kaur *et al.* (2000).

The Zinc content under *Acacia nilotica* (1.32 mg kg^{-1}) land use system was significantly higher and showed on par with *Azadiracta indica* (1.27 mg kg^{-1}), *Tectona grandis* (1.26 mg kg^{-1}). Among the plant species Zinc content under *Albizia lebbeck*, *Dalbergia sisso, Eucalyptus teticornis, Pongamia pinnata* varied from 0.50 mg kg^{-1} to 0.055 mg kg^{-1} and higher over fallow land(Table.3). This might due to increased nutrient availability, root activity, plant residue contains higher Zinc content. Similar results were obtained by Benton (2002), Kiran Bargali and Bargali (2009).

The Iron content was higher in *Acacia nilotica* (5.84 mg kg^{-1}) fallowed by *Eucalyptus teticornis* (4.24 mg kg^{-1}), *Dalbergia sisso* (3.97 mg kg^{-1}), *Tectona grandis* (3.74 mg kg^{-1}) and *Azadiracta indica* (3.57 mg kg^{-1}) (Table.4). High Iron content under *Acacia nilotica* land use systems attributed to high iron accumulation in *Acacia* plant residues it was supported by Benton (2002), Kiran Bargali and S.S.Bargali (2009).

The copper content under *Acacia nilotica* (1.67 mg kg^{-1}) land use system was significance higher over other land use systems (Table.2) and showed on par with *Albergia lebbeck* (1.47 mg kg^{-1}) and *Dalbergia sissoo* (1.17 mg kg^{-1}). It is due to *Acacia nilotica* plant leaf contains high cu content it. Supported by Benton (2002), Kiran Bargali and Bargali (2009). Among the plant species cu content under *Tectona grandis* (0.87 mg kg^{-1}), *Pongamia pinnata* (0.72 mg kg^{-1}), and low cu content recorded in *Eucalyptus tetranicus* (0.69 mg kg^{-1}) and significantly on par with fallow land contents (0.62 mg kg^{-1})

Table 1. Organic Carbon content (%) in multipurpose tree systems at different depths of different location in ANGRAU Campus

Depth (cm)	0-30cm						30-60cm						60-90cm					
Locations	Student farm	College farm	ARI	Horti-culture college	Veteri-nary college	Mean	Student farm	College farm	ARI	Horti-culture college	Veteri-nary college	Mean	Student farm	College farm	ARI	Horti-culture college	Veteri-nary college	Mean
Fallow land	0.03	0.07	0.16	0.03	0.14	0.09	0.02	0.06	0.12	0.13	0.11	0.09	0.01	0.02	0.11	0.17	0.1	0.08
Acacia nilotica	0.28	0.21	0.25	0.26	0.28	0.26	0.19	0.17	0.18	0.21	0.23	0.20	0.14	0.15	0.13	0.19	0.17	0.16
Azadiracta indica	0.03	0.07	0.16	0.03	0.14	0.09	0.17	0.19	0.19	0.11	0.15	0.16	0.15	0.18	0.16	0.10	0.13	0.14
Dalbergia sisso	0.22	0.25	0.19	0.18	0.18	0.20	0.24	0.26	0.23	0.21	0.28	0.24	0.18	0.16	0.17	0.19	0.16	0.17
Eucalyptus tetranicus	0.24	0.23	0.25	0.24	0.28	0.25	0.19	0.18	0.16	0.15	0.19	0.17	0.11	0.16	0.15	0.13	0.16	0.14
Albergia lebbeck	0.42	0.46	0.58	0.48	0.43	0.47	0.31	0.35	0.33	0.38	0.34	0.34	0.24	0.27	0.26	0.22	0.27	0.25
Pongamia pinnata	0.57	0.54	0.52	0.57	0.67	0.57	0.43	0.41	0.31	0.34	0.41	0.38	0.36	0.26	0.24	0.22	0.37	0.29
Tectona grandis	0.38	0.31	0.29	0.27	0.24	0.30	0.21	0.25	0.24	0.19	0.16	0.21	0.14	0.19	0.23	0.16	0.11	0.17
Mean	0.30	0.31	0.32	0.29	0.33	0.31	0.22	0.23	0.21	0.21	0.23	0.22	0.16	0.17	0.18	0.17	0.18	0.18
SEM ±	0.06						0.06						0.06					
CD(0.05)	15.89%						15.46%						25.23%					
CV%	0.03						0.07						0.16					

Table 2 Copper content (mg kg^{-1}) under multipurpose tree systems in different depths of different locations in ANGRAU campus

Depth / Locations / Student farm		0-30 cm						30-60 cm						60-90 cm					
		College farm	Agricultural Research Inistute (ARI)	Horti-culture college	Veterinary college	Mean	Student farm	College farm	ARI	Horti-culture college	Veterinary college	Mean	Student farm	College farm	ARI	Horti-culture college	Veterinary college	Mean	
Treatments	Land use system																		
T_1.	Fallow land	0.76	0.54	0.65	0.57	0.57	0.62	0.65	0.52	0.54	0.51	0.54	0.55	0.51	0.44	0.47	0.44	0.54	0.48
T_2.	Acacia nilotica	1.78	1.57	1.81	1.49	1.72	1.67	1.63	1.55	1.76	1.26	1.70	1.58	1.34	1.50	1.54	1.05	1.59	1.40

T_3.	Azadiracta indica	0.56	0.71	0.63	0.55	0.65	0.62	0.42	0.53	0.41	0.52	0.44	0.46	0.30	0.44	0.40	0.53	0.43	0.42
T_4.	Dalbergia sissoo	1.34	1.51	1.43	0.57	1.02	1.17	1.20	1.74	1.32	1.46	0.97	1.34	0.66	0.34	0.26	0.40	0.50	0.43
T_5.	Eucalyptus tereticornis	0.63	0.56	0.97	0.65	0.65	0.69	0.52	0.53	0.74	0.60	0.64	0.61	0.50	0.50	0.70	0.52	0.60	0.56
T_6.	Albizia lebbeck	1.91	1.64	0.84	1.53	1.42	1.47	1.87	1.43	0.79	1.47	1.33	1.38	0.57	0.46	0.65	0.82	0.52	0.60
T_7.	Pongamia pinnata	0.96	0.88	0.54	0.44	0.77	0.72	0.86	0.79	0.48	0.38	0.66	0.63	0.51	0.69	0.40	0.36	0.54	0.50
T_8.	Tectona grandis	1.11	0.53	1.21	0.94	0.54	0.87	1.24	1.53	1.29	0.87	0.53	1.09	0.79	0.51	0.82	0.64	0.42	0.64
	Mean	1.13	0.99	1.01	0.84	0.91		1.04	1.07	0.91	0.88	0.85		0.64	0.61	0.65	0.59	0.64	
	SEM ±	0.11						0.11						0.07					
	CD(0.05)	0.32						0.31						0.19					
	CV%	24.9%						24.8%						23.16%					

Table 3 Zn content (mg kg^{-1}) under multipurpose tree systems in different depths of different locations in ANGRAU campus

Depth (cm) Locations		0-30 cm						30-60 cm						60-90 cm					
Student farm		College farm	Agricultural Research Inistute (ARI)	Horti-culture college	Veterinary college	Mean	Student farm	College farm	ARI	Horti-culture college	Veterinary college	Mean	Student farm	College farm	ARI	Horti-culture college	Veterinary college	Mean	
Treatments	Land use system																		
T_1.	Fallow land	0.23	0.21	0.34	0.35	0.23	0.27	0.20	0.18	0.46	0.25	0.18	0.25	0.19	0.13	0.14	0.18	0.15	0.16
T_2.	Acacia nilotica	1.44	1.13	1.11	1.50	1.43	1.32	1.20	0.96	0.97	1.23	1.32	1.14	0.88	0.68	0.67	0.64	0.92	0.76
T_3.	Azadiractaindica	1.32	1.39	1.11	1.23	1.31	1.27	1.15	1.26	1.03	1.10	1.12	1.13	1.30	0.98	0.86	0.91	0.95	1.00
T_4.	Dalbergia sissoo	0.54	0.45	0.43	0.58	0.68	0.54	0.32	0.36	0.39	0.43	0.41	0.38	0.21	0.29	0.23	0.31	0.34	0.28
T_5.	Eucalyptus tereticornis	0.71	0.63	0.36	0.56	0.42	0.54	0.53	0.52	0.27	0.48	0.39	0.44	0.41	0.46	0.21	0.43	0.36	0.37
T_6.	Albizia lebbeck	0.51	0.54	0.53	0.49	0.42	0.50	0.45	0.48	0.44	0.35	0.37	0.42	0.31	0.35	0.32	0.32	0.31	0.32
T_7.	Pongamia pinnata	0.56	0.59	0.43	0.62	0.53	0.55	0.42	0.45	0.43	0.51	0.46	0.45	0.32	0.36	0.37	0.39	0.35	0.36
T_8.	Tectona grandis	1.20	1.51	1.30	1.24	1.10	1.26	1.11	1.22	1.00	0.94	0.93	1.04	0.91	0.94	0.89	0.85	0.82	0.88
	Mean	0.81	0.80	0.70	0.81	0.76		0.67	0.67	0.62	0.66	0.64		0.56	0.52	0.46	0.50	0.52	
	SEM ±	0.05						0.05						0.04					
	CD(0.05)	0.15						0.14						0.11					
	CV%	14.3%						15.9%						16.76%					

Depth (cm) Locations		0-30cm						30-60cm						60-90cm					
Student farm		College farm	ARI	Horticulture college	Veterinary college	Mean	Student farm	College farm	ARI	Horticulture college	Veterinary college	Mean	Student farm	College farm	ARI	Horticulture college	Veterinary college	Mean	
Treatments	Land use system																		
T_1.	Fallow land	0.28	0.26	0.27	0.22	0.35	0.28	0.25	0.24	0.25	0.25	0.28	0.25	0.23	0.24	0.23	0.23	0.26	0.24
T_2.	Acacia nilotica	7.72	6.53	7.43	3.18	4.32	5.84	6.43	6.31	7.31	3.10	4.21	5.47	6.25	6.12	6.35	3.12	4.20	5.21
T_3.	Azadiracta indica	3.71	4.87	3.26	2.60	3.42	3.57	2.03	3.22	2.26	2.31	3.32	2.63	1.31	2.43	2.10	2.00	2.97	2.16
T_4.	Dalbergia sissoo	3.75	5.31	5.21	2.33	3.27	3.97	3.21	4.16	4.39	2.12	2.65	3.31	3.01	4.80	4.10	2.01	2.75	3.33
T_5.	Eucalyptus tereticornis	3.56	5.72	4.32	3.65	3.97	4.24	3.18	4.96	4.22	3.22	3.24	3.76	3.02	4.51	4.01	2.64	3.10	3.46
T_6.	Albizia lebbeck	3.09	3.22	2.8	3.11	3.28	3.10	2.97	3.10	2.26	2.86	2.96	2.83	2.81	2.98	2.43	2.54	2.52	2.66

T_7.	Pongamia pinnata	3.49	3.19	2.32	3.19	3.19	3.08	3.27	2.99	2.46	3.01	3.01	2.95	3.21	2.67	2.10	2.79	2.96	2.75
T_8.	Tectona grandis	3.54	4.23	3.26	3.43	4.23	3.74	3.42	3.65	3.27	3.22	3.25	3.36	2.26	3.23	3.01	3.02	3.19	2.94
	Mean	3.64	4.16	3.60	2.71	3.25		3.09	3.57	3.30	2.51	2.86		2.76	3.37	3.04	2.29	2.74	
	SEM ±	0.39					0.33							0.31					
	CD (0.05)	1.12					0.96							0.91					
	CV%	24.84%					24.2%							24.6%					

Table 4 Iron content (mg kg^{-1}) under multipurpose tree systems in different depths of different locations in ANGRAU campus

REFERENCE

Benton, J. 2002. Agronomic Hand Book. Management of crops soils and their fertility. CRC Press, Boca Raton, London, New York, Washington. | Dadhwal,V.K., Nayak. and Shah,A.K.(1993). Recent changes (1982-1991) in forest phytomas carbon pool in india estimated using growing stock and remote sensing –based forest inventories. Journal of Tropical Forestry.13: 182-188. | Deans, J.D., Diagne, O., Lindley, D.K., Dione, M. and Parkinson, J.A. 1999. Nutrients and organic-matter accumulation in Acacia senegal fallows over 18 years. Forest Ecology Management. 124:153–167. | George, T.S., Gregory. P.J., Robinson, J.S. and Buresh, R.J. 2002. Changes in phosphorus concentrations and pH in the rhizosphere of some Agroforestry and crop species. Plant Soil (in press). | Jackson, M.L. 1967. Soil chemical analysis. Prentice Hall India Pvt. Ltd., New Delhi. p. 498. | Jakubaschk, C. 2002. Acacia Senegal, soil organic carbon and nitrogen contents: A study in North Kordofan, Sudan, PhD dissertation, Lund University, Sweden. | Kaur, B., Gupta, S.R. and Singh, G. 2000. Soil Carbon, Microbial Activity and Nitrogen availability in Agroforestry systems on moderately alkaline soils in Northen India. Applied Soil Ecology. 15:283-294. | Kavvadias, V.A., Alifragris, D., Tsiontsis, A., Brofas, G. and Stamatelos, G. 2001. Litter fall, litter accumulation and litter decomposition rates in four forest ecosystems in northern Greece. For E.coli Manage. 144:113–127. | Kiran Bargali and Bargali, S.S. 2009. Acacia nilotica: a multipurpose leguminous. Plant Nature and Science. 7(4), ISSN 1545-0740. | Lindsay, W.L. and Norvell, W.L. 1978. Development of a DTPA soil test for zinc, iron, manganese and copper. Soil Science Society of American Journal. 42:421-428. | Olsen, S.R., Cole, C.V., Watanabe, F.S. and Dean, L.A. 1954. Estimation of available phosphorus in soil by extraction with sodium bicarbonate. U.S.D.A. Circ.p.939. | Panse,V,G. and Shuhatme, P,V. 1985. Statistical methods for agricultural workers, 4th edition., ICAR, New Delhi. | Raddad, E.Y., Luukkanen, E.O., Salih, E.A.A., Kaarakka, E.V. and Elfadl, E.M.A. 2006. Productivity and nutrient cycling in young Acacia Senegal farming systems on Vertisol in the Blue Nile region, Sudan. Agroforestry Systems. 68:193–207. | Shanmughavel, P. and K. Francis. 1998. Litter production and nutrient return in teak plantation. Van Vigyan. 36:128-133. | Subbaiah, B.V. and Asija, G.L. 1956. A rapid procedure of estimation of available nitrogen in soils. Current Science. 65 (7): 477-480. | | Lal, R.: 2001, 'The Physical Quality of Soils on Grazing Lands and Its Effects on Sequestering Carbon', in Follett, R. F., Kimble, J., and Lal R., (eds.), The Potential of US Grazing Lands to Sequester Carbon and Mitigate the Greenhouse Effect, Lewis Publishers, Boca Raton, FL,pp. 249–266. | | McConkey, B. G., Liang, B. C., and Campbell, C.A.: 1999, Estimated gains of soil carbon over 15-yr period due to changes in fallow frequency, tillage system and fertilization practices for the Canadian prairies (an expert opinion), Semiarid Prairie Agricultural Research Centre, Miscellaneous Publication No. 379M0209, Agriculture and Agri-Food Canada, Ottawa, ON. | |