

Original Research Article

<https://doi.org/10.20546/ijcmas.2018.709.269>

A Study of Selected Carbon Fractions in Soil under Arecanut Based Cropping Systems of Coastal Zone of Karnataka

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ABSTRACT

Keywords

Carbon fractions, Areca nut based cropping systems

Article Info

Accepted:

16 August 2018

Available Online:

10 September 2018

An investigation was undertaken at, Department of Soil Science and Agricultural Chemistry, College of Agriculture, UAHS, Shivamogga to a study of selected carbon fractions in soil under Areca nut based cropping systems of coastal zone (10) of Karnataka. Among the cropping systems studied, arecanut + mixed recorded higher mean potassium permanganate oxidizable organic carbon (1387.33mg kg^{-1}), cold water extractable carbon (391.63mg kg^{-1}), total carbon (23.52 g kg^{-1}), total organic carbon (18.70g kg^{-1}), total inorganic carbon ($0.0.1618\text{g kg}^{-1}$) and soil microbial biomass carbon (373.33mg kg^{-1}) fractions as compared to other cropping systems and decreases with lower depth and carbon fractions were higher in 0-30cm soil depth.

Introduction

Areca nut is growing as plantation crop in India besides it is an important cash crops in western and Eastern Ghats, east and north eastern regions of India. In areca nut based cropping system like pepper, cocoa, banana, zinger, turmeric, citrus, cardamom, medicinal and aromatic plants, flowers crops, coffee, etc. are the major crops generally growing as intercrop, mixed crop and high density multi-storey crops. Higher soil loss, organic matter and nutrient loss is due to soil erosion and leaching of nutrients in coarse textured soil mainly with heavy rains. The yield level of areca nut, intercrops and mixed crops and soil fertility status are invariably depends upon the

soil organic carbon status and nutrients management practices as well as other conservation strategies. Soil organic carbon status is the key to soil fertility, crop productivity and rising atmospheric temperature in the areca nut plantations of Western Ghats regions. Organic carbon is one of the five components of soil. During the process of soil formation, plant life begins to appear as soon as the products of weathering offer a suitable medium for its growth.

The vegetation so produced now take part in more intensive weathering and soil formation both during its growth and subsequently after it is incorporated with the mineral matter on completing its life cycle. The high organic

carbon content in silvi system, eucalyptus and horti system, Areca nut might be due to litter fall. The highest amount of organic carbon content at the surface layers of the soil was due to the accumulation of organic matter in surface horizon and recycling of organic matter and also because of crop residues remaining in soil surface (Ashok, 1998).

Materials and Methods

The study will be covering coastal region of Karnataka, Dakshia Kannada and Udupi. The latitude and longitude coordinates of coastal region (Zone 10) are 12.520°N 74.50 0 °E.

A study was conducted at UAHS, Shivamogga to a study of selected carbon fractions in soil under Arecanut based cropping systems of coastal zone of Karnataka.

Soil samples will be collected from 0-30 cm, 30-60 cm and 60-90 cm to study further distribution of soil carbon pools in lower depth (60-90cm) of different areca nut based cropping systems.

Representative soil samples were collected from 0-30 cm, 30-90 cm and 60-90 cm depth from 2 location of different areca nut based cropping systems.

Selected carbon fractions were analysed by adopting standard procedure, determination of potassium dichromate oxidizable organic carbon was carried out by wet oxidation method by (Walkley and Black, 1934), potassium permanganate oxidizable organic carbon was carried out as per the procedure described by Blair *et al.*, (1995), estimation of cold water extractable carbon (CWEC) was carried out as per the method described by McGill *et al.*, (1986), the microbial biomass carbon (MBC) was analyzed by following chloroform fumigation method (Vance *et al.*, 1987). Estimation of total carbon, total

inorganic carbon and total organic carbon was carried out using total organic carbon (TOC) analyzer. The commonly used method is the catalytic combustion or oxidation method.

Results and Discussion

The soil organic carbon content decreased with depth in all areca nut based cropping Systems. The surface (0-30 cm) soil registered higher organic carbon content than subsurfaces *i.e.*, 30-60 and 60-90 cm depths. Higher OC (g kg^{-1}) in areca nut +mixed systems (23.80 g kg^{-1}) in 0-30 cm and lower OC was observed in areca nut sole system (12.90 g kg^{-1}) decreases among the soil depth. Soil from Udupi show higher OC(g kg^{-1}) in areca nut +cocoa systems (19 g kg^{-1}) followed by areca nut +mixed (19.00 g kg^{-1}) in 0-30 cm shown in Table 1 and lowest OC was observed in areca nut sole (14.90 g kg^{-1}) system and decreases among the soil depth which is shown in Table 1.

In zone 10, Mangalore region show higher potassium permanganate oxidizable carbon (PPOC) in surface soil of Areca nut +Mixed systems (1597 mg kg^{-1}) in 0-30 cm and lower was in areca nut sole ($585. \text{ mg kg}^{-1}$) and which decreases in lower depths in all systems and soil from Udupi region show higher PPOC in ($1070.4 \text{ mg kg}^{-1}$) in areca nut +mixed in 0-30 cm and lower was in areca nut + banana (715.1 mg kg^{-1}) decreases in lower depths in all systems, which is shown in Table 2.

In Zone 10, Mangalore region show higher Cold water extractable carbon (CWEC) in surface soil of areca nut +mixed systems ($426. \text{ mg kg}^{-1}$) in 0-30 cm and lower was in areca nut sole ($312. \text{ mg kg}^{-1}$) and decreases in lower depth and soil from Udupi region show higher (399.2 mg kg^{-1}) in areca nut +mixed in 0-30 cm and lower was in areca nut+ banana (299.2 mg kg^{-1}) decreases among the soil depth which is shown in Table 3.

Table.1 Soil organic carbon under different areca nut based cropping system of zone 10

District	Cropping systems	SOC (g /kg)			Mean
		Depth (cm)			
		0-30	30-60	60-90	
Mangalore	Arecanut+Mixed	23.80	10.90	17.00	17.23
	Arecanut+Banana	17.70	8.10	13.60	13.13
	Arecanut+Pepper	14.30	13.60	12.90	13.60
	Arecanut+Cocoa	16.70	12.90	14.30	14.63
	Arecanut Sole	12.90	8.80	8.80	10.16
Range		12.90-23.80	8.80-13.60	8.80-17.00	
Mean		17.08	10.86	13.32	
Udupi	Arecanut+Mixed	19.00	13.60	8.80	13.80
	Arecanut+Banana	19.00	10.90	16.30	15.40
	Arecanut+Pepper	16.30	9.50	13.60	13.13
	Arecanut+Cocoa	19.10	12.20	9.50	13.60
	Arecanut Sole	14.90	6.00	9.50	10.13
Range		14.90-19.00	6.00-13.60	8.80-16.30	
Mean		17.66	10.44	11.54	

Note: * SOC- Soil organic carbon

Table.2 Potassium permanaganate oxidizable carbon under different areca nut based cropping system of zone 10

District	Cropping systems	PPOC (mg Kg ⁻¹)			Mean
		Depth (cm)			
		0-30	30-60	60-90	
Mangalore	Arecanut+Mixed	1597	1350	1215	1387.33
	Arecanut+Banana	922.5	720	697.5	780
	Arecanut+Pepper	717.75	612	567	632.25
	Arecanut+Cocoa	650.25	699.7	582.7	644.21
	ArecanutSole	585.1	517.5	509	537.20
Range		585.1-1597	517.5-1350	509-1215	
Mean		894.52	779.84	714.24	
Udupi	Arecanut+Mixed	1070.4	975	968.1	1004.50
	Arecanut+Banana	715.1	675	634.5	674.86
	Arecanut+Pepper	789.7	740.25	724.5	751.48
	Arecanut+Cocoa	814.5	805.5	769.5	796.50
	Arecanut Sole	717.7	657	627.4	667.36
Range		715.1-1070.4	657-975	627.4-968.1	
Mean		821.48	770.55	744.8	

Note:* PPOC- Potassium Permanaganate Oxidizable Carbon

Table.3 Cold water extractable carbon under different arecanut based cropping system of zone 10

District	Cropping systems	CWEC (mg Kg ⁻¹)			Mean
		Depth (cm)			
		0-30	30-60	60-90	
Mangalore	Arecanut+Mixed	426.1	397.8	351.0	391.63
	Arecanut+Banana	381.1	376.5	351.0	369.53
	Arecanut+Pepper	356.2	345.6	367.8	356.53
	Arecanut+Cocoa	376.5	369.7	367.1	371.10
	Arecanut Sole	312.6	305.8	332	316.80
Range		312.60-426.10	305.80-397.80	332-367.8	
Mean		370.50	359.08	353.78	
Udupi	Arecanut+Mixed	399.2	365.2	340.9	368.43
	Arecanut+Banana	299.0	301.0	285.3	295.10
	Arecanut+Pepper	303.2	286.5	266.5	285.40
	Arecanut+Cocoa	377.4	374.4	361.4	371.06
	Arecanut Sole	316.2	264.7	315.2	295.36
Range		299.0-399.2	264.7-374.4	266.5-361.4	
Mean		339.00	318.36	311.86	

Note:* CWEC- Cold Water Extractable Carbon

Table.4 Soil microbial biomass carbon under different arecanut based cropping system of zone 10

District	Cropping systems	SMBC (mg Kg ⁻¹)			Mean
		Depth (cm)			
		0-30	30-60	60-90	
Mangalore	Arecanut+Mixed	381	362	368	370.33
	Arecanut+Banana	355	351	340	348.66
	Arecanut+Pepper	371	321	311	334.33
	Arecanut+Cocoa	340	334	322	332.00
	Arecanut Sole	325	322	318	321.66
Range		325-381	321-362	311-368	
Mean		354.4	338.8	331.8	
Udupi	Arecanut+Mixed	379	372	369	373.33
	Arecanut+Banana	312	310	310	310.66
	Arecanut+Pepper	377	345	328	350.00
	Arecanut+Cocoa	355	356	341	350.66
	Arecanut Sole	341	333	306	326.66
Range		312-379	310-372	310-369	
Mean		352.8	343.2	344.8	

Note: * SMBC- Soil Microbial Biomass Carbon

Table.5 TC (g kg⁻¹) under different areca nut based cropping system of zone 10

Zone10	Cropping System	TOC(g kg ⁻¹)			Mean	TIC(g kg ⁻¹)			Mean	TC(g kg ⁻¹)		
		Depth(cm)				Depth(cm)				Depth(cm)		
		0-30	30-60	60-90		0-30	30-60	60-90		0-30	30-60	60-90
	Arecanut+Mixed	23.4	20.3	12.4	18.70	0.1216	0.1257	0.1421	0.1298	23.52	20.42	12.54
	Arecanut+Banana	16.21	14.4	16.15	15.50	0.1237	0.1532	0.2084	0.1618	16.33	14.55	16.35
	Arecanut+Pepper	14.25	13.2	12.85	13.40	0.1342	0.1253	0.1942	0.1512	14.38	13.32	13.04
	Arecanut+Cocoa	22.00	10.03	13.41	15.10	0.1195	0.1244	0.1732	0.1390	22.11	10.15	13.58
	Arecanut Sole	10.80	9.40	7.70	9.30	0.1204	0.1302	0.1525	0.1344	10.92	9.53	7.85
Mean		17.30	13.40	12.50		0.1239	0.1318	0.1740		17.45	13.59	12.61

Note: *TOC- Total organic carbon

*TIC- Total inorganic carbon

*TC- Total carbon

In zone 10, Mangalore region show higher Soil microbial biomass carbon (SMBC) in areca nut +mixed systems (381 mg kg^{-1}) in 0-30 cm and lower was observed in areca nut sole (325 mg kg^{-1}) system and decreases in lower depth sand soil from Udupi show higher MBC in areca nut +mixed (379 mg kg^{-1}) in 0-30 cm and lower was observed in areca nut +banana (312 mg Kg^{-1}) and which decreases among the soil depth in all which is shown in Table 4.

In zone 10, Total organic carbon (TOC g kg^{-1}) was observed higher in surface soil of areca nut +mixed (23.4 g kg^{-1}) and lowest was in areca nut sole (10.8 g kg^{-1}) and decreases in lower depth. TIC was observed higher in areca nut +banana (0.2084) in 60-90 cm soils and lower was in surface soil of areca nut +cocoa (0.1195) which is shown in Table 5.

In zone 10, Total carbon (TC) was observed higher in surface soil of areca nut + mixed (23.52 g kg^{-1}) and lower was observed in areca nut sole (10.92 g kg^{-1}) and decreases in lower depth which is shown in Table 5.

The soil organic carbon content of surface soil (17.66 g kg^{-1}) was higher than that of subsurface soil layer (13.32 g kg^{-1}) which was due to higher litter fall and greater humification of soil organic carbon in surface soil (Geo Jose, 2006) The mean SOC value of areca nut +mixed show significantly higher value (17.23 g kg^{-1}) and areca nut sole show lower mean SOC value (10.13 g kg^{-1}), among the different areca nut based cropping systems which is shown in Table 1.

In areca nut garden, due to the growth of weeds, less disturbance of soil and shading effect of the tree, there was relatively more accumulation of SOC than in soils under paddy and maize land use cover. These results are in conformity with results of Bayer and Bertol (2000).

Among the cropping systems, areca nut + mixed was recorded higher mean potassium permanganate oxidizable organic carbon ($1387.33 \text{ mg kg}^{-1}$) and the lower mean potassium permanganate oxidizable organic carbon was observed under areca nut sole ($537.20 \text{ mg kg}^{-1}$). The range of PPOC value suggests that PPOC content increased in the beginning which decreased progressively with time. Such behavior indicates that this fraction changes with time because of its dynamic in nature. Application of organic sources with fertilizer significantly increased EOC content over fertilizer control. Verma *et al.*, (2010) reported that labile pools of SOC were increased with increasing amount of added manures.

Among areca nut based cropping system and depths, areca nut+ mixed was recorded higher mean cold water extractable carbon ($391.63 \text{ mg kg}^{-1}$) and the lower mean cold water extractable carbon content was observed under areca nut sole ($295.36 \text{ mg kg}^{-1}$). This might be due to higher build-up of soil organic carbon, water soluble carbon and labile carbon on surface soil depth under areca nut+ mixed system might be attributed to the accumulation of litter fall on surface layer of soil. The subsequent decomposition and incorporation of litter into soil would have helped in raising the soil organic carbon pool status of soil (Gill *et al.*, 1987).

Among the cropping systems, areca nut+ mixed was recorded higher mean MBC ($373.33 \text{ mg kg}^{-1}$) and the lower mean MBC was observed under ($321.66 \text{ mg kg}^{-1}$) with. The variations in soil SMB-C among different areca nut based cropping system may be attributed to variation in soil organic matter content consequently the microbial activity. Further the variation in SOM may be attributed to variation in biomass return to soil and addition of manure. The variations in soil microbial biomass among different areca nut

based cropping systems may be attributed to organic matter turnovers. Organic matter in the form of litter, compost or any other form serves as source of energy for soil microbes. Brij *et al.*, (2012) reported highest SMBC under the forest and horticultural land use systems and attributed it to higher amount of substrate for proliferation of microorganisms.

Soils under areca nut+ mixed land use were recorded higher mean TOC (18.70g kg^{-1}) and the lower mean TOC was observed under soils of areca nut sole (9.30 g kg^{-1}). This variation is due to the continuous cropping and soil cultivation has caused 47 per cent of soil organic carbon losses in the surface 0-15 cm depth, which is probably due to the rapid decomposition of native soil organic matter has been reported by Fayeze (2006). Soils under areca nut+ Banana show higher mean of (0.1618g kg^{-1}) and the lower mean TIC was observed under soils of areca nut Sole (0.1344g kg^{-1}). TIC content varied widely among the cropping system, most of the total inorganic carbon is associated with calcium and magnesium carbonates.

In present study areca nut sole and banana recorded the lower TIC compare to other land use due to low pH (4.72) which was strongly acidic in nature which contains very low Ca and Mg carbonates compare to other land use cover Similar results was in accordance with Venkanna *et al.*, (2014).

Soils from areca nut+ mixed recorded the higher TC (23.52 g kg^{-1}) and the lower mean TC was observed soil under areca nut Sole (7.85g kg^{-1}) the higher total carbon in areca nut+ mixed is due to higher litter fall in the system. Higher TC was observed under forest cover and areca nut land use due to high organic matter turn over, high rate of decomposition and minimal land disturbance, this result are similar in accordance with Dalal and Mayer (1986)

The soil organic carbon fractions were lower in Arecanut sole and Arecanut + mixed systems having higher organic carbon among different systems Carbon fractions were higher in 0-30cm soil depth and decreases in lower depth of areca nut based cropping systems. So it can conclude that the soil carbon fraction properties significantly vary among different arecanut based cropping use systems.

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How to cite this article:

Apurva, V., Ganapathi and Mallesh, K.U. 2018. A Study of Selected Carbon Fractions in Soil under Arecanut Based Cropping Systems of Coastal Zone of Karnataka. *Int.J.Curr.Microbiol.App.Sci*. 7(09): 2184-2192. doi: <https://doi.org/10.20546/ijcmas.2018.709.269>