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The Role of Forestry Plantations in Soil Carbon Sequestration in a Reserved Forest in North-Western India

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Abstract: The aim of this study was to analyze soil carbon stock, carbon storage in soil aggregates and clay mineralogy in *Eucalyptus tereticornis*, *Prosopis juliflora* and *Dendrocalamus hamiltonii* (located at Seonthi Reserved Forest, Kurukshetra, 29°59'N and 76°59'E; Altitude is 247 m above msl) in north-western India. The climate of the study area is tropical monsoonal and semiarid. The soil pH varied from 7.44 to 8.11. The organic carbon stock upto 0-60cm soil depth varied from 16.677 to 2.983 Mg C ha^{-1}; inorganic carbon was 1.344 to 4.360 Mg C ha^{-1}. The microaggregates (250µm-53µm) and sand and silt associated fractions (<53 µm) formed a large fraction of soil aggregates and protected most of soil organic carbon. The total carbon content was higher in microaggregates (250µm-53µm) as compared to silt and clay associated soil fractions (<53µm). Montmorillonite, chlorite, illite, chasmosite, kaolinite and vermiculite were found to be the main clay minerals in soils of the three tree plantations. Tree plantations were found to have a marked potential for carbon sequestration by improving soil structure, soil aggregation and increasing soil carbon. Tree plantations of fast growing species in the reserved forest were found to be an effective strategy for forest restoration, carbon sequestration and conservation of biodiversity.

Key words: Soil Carbon Sequestration · Soil Aggregates · Soil Aggregate Carbon · Clay Mineralogy · X-ray Diffraction

INTRODUCTION

Carbon management in forests and tree plantations play an important role to mitigate global climate change. Plantations with fast growing species have a direct impact on the regional rate of carbon sequestration by incorporating carbon into the plant biomass and improving soil organic matter. Soil organic matter is a renewable resource and it can be maintained at a steady state if degraded ecosystems can be restored [1]. Soil organic matter is the source of essential nutrients, which acts as a source of food for soil organisms and stabilizes soil structure [1]. Soil carbon also plays an important role in maintaining soil productivity that makes land management systems sustainable, resilient and able to resist degradation. Soil carbon sequestration, the process by which atmospheric carbon dioxide is taken up by plants through photosynthesis and stored as carbon in biomass and soils, can help maintain soil fertility, reduce the emission of greenhouse gases in the atmosphere and reduce the impact of climate change on forestry ecosystems. The patterns and controls of soil organic carbon (SOC) storage are critical for our understanding. Soil organic carbon is controlled by the balance of C inputs from plant production and outputs through decomposition [2].

An aggregate is a naturally occurring cluster or group of soil particles, which helps in movement of air and water through the soil and protection of soil organic matter, prevention of erosion, root penetration and microbial activity [3, 4]. Soil organic carbon associated with aggregates is an important reservoir of carbon, protected from mineralization and enzymatic degradation [5]. Physical fractionation techniques have been used to separate soil organic matter pools in to primary particles (sand, silt and clay), microaggregates (53-250µm) and macroaggregates (>250µm) [3].

Clay minerals strongly influence the major physical and chemical properties of soil as well as soil organic matter and its chemical nature. Organic molecules tucked within a clay interlayer would be protected from microbial degradation, potentially forming a very stable and long-

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lived pool of soil carbon. Organic materials have been found within the interlayers of smectite minerals obtained from a few different soil ecosystems [6, 7]. Soils with higher clay content sequester carbon at higher rates. However, studies on clay mineralogy need more attention to analyze the effect of interparticle interactions of the soil minerals and soil carbon stability. The soil carbon sequestration depends on clay contents and mineralogy, structural stability, moisture and temperature regimes and formation of soil aggregates [8].

The aim of this study was to analyze soil organic and inorganic carbon sequestration, carbon storage in soil aggregates and the role of clay mineralogy in soil carbon stability in forestry plantations.

MATERIALS AND METHODS

Study Site: The study site is located at Seonthi Reserve Forest, Kurukshetra, north-western India. The area fall between 29°59'North latitude, 76°59'East longitudes; Altitude is 247 m above mean sea level. The tree plantations of *Eucalyptus tereticornis*, *Prosopis juliflora* which were about 25 year old and *Dendrocalamus hamiltonii* about 10 year old were selected for the study at Seonthi Reserve Forest.

Climate of the study area is tropical monsoonal and semiarid. The year is divisible into a warm wet period (June to September; rainy season), a cool dry period (October to February; winter season) and a hot dry period (March to May; summer season). Soil of the study area is old alluvium which is sandy-loam in texture [9]. The soil of the study area shows a pH of 7.44 to 8.11 and electric conductivity varied from 1.17 to 1.80 dSm^{-1} which indicated slightly alkaline soil reaction. The bulk density in different tree plantations varied from 1.09 to 1.53 gm^{-3} (Table 1).

A total of 51 plant species were recorded in all the three plantations. The number of species was greater in *Eucalyptus tereticornis* (47) as compared to *Dendrocalamus hamiltonii* (25) and *Prosopis juliflora* (19) plantations. The ground floor vegetation in *Eucalyptus tereticornis* plantation was mainly dominated by *Desmostachya bipinnata* Stapf. (density=73.9 plants m^{-2}) and composed of other grasses including *Brachiaria reptans* (L.) Gard. (density=8.4 plants m^{-2}), *Panicum miliare* Lamk. (density=7.4 plants m^{-2}), *Achyranthes aspera* L. (density=7.3 plants m^{-2}), *Setaria glauca* (L.) Beauv. (density=6.7 plants m^{-2}), *Barleria cristata* L. (density=6.7 plants m^{-2}), *Capparis sepiaria* L. (density=3.5 plants m^{-2}), *Adhatoda zeylanica* Medic. (density=2.8 plants m^{-2}) and *Ziziphus nummularia* (Burm.f.) W. and K. (density=2.6 plants m^{-2}).

The herbaceous ground floor in *Dendrocalamus hamiltonii* plantation was composed of *Desmostachya bipinnata* Stapf. (density=20.4 plants m^{-2}), *Commelina benghalensis* L. (density=11.4 plants m^{-2}), *Brachiaria reptans* (L.) Gard. (density=11.0 plants m^{-2}), *Melochia corcharifolia* L. (density=3.6 plants m^{-2}), *Ziziphus nummularia* (Burm.f.)W. and K. (density=3.1 plants m^{-2}) and *Adhatoda zeylanica* Medic. (density=2.3 plants m^{-2}).

The ground floor was poor in *Prosopis juliflora* plantation, with low density of *Desmostachya bipinnata* Stapf. (density=16.0 plants m^{-2}), *Commelina benghalensis* L. (density=2.1 plants m^{-2}), *Malvastrum coromandelianum* (L.) Garcke (density=1.9 plants m^{-2}), *Phyllanthus reticulatus* Poir. (density=2.8 plants m^{-2}) and *Capparis sepiaria* L. (density=2.2 plants m^{-2}), because of thick shade of trees.

Table 1: Some physical and chemical soil characteristics at different soil depth in tree plantations of *Eucalyptus tereticornis*, *Prosopis juliflora* and *Dendrocalamus hamiltonii* at Seonthi Reserve Forest, Kurukshetra (± Standard error)

Tree plantation	Soil depth (cm)	pH (1:2)	Organic carbon (%)	Inorganic carbon (%)	Bulk density ($g\ m^{-3}$)
Eucalyptus tereticornis	0-15	7.44±0.14	0.79±0.02	0.13±0.002	1.15±0.04
	15-30	7.56±0.17	0.47±0.02	0.14±0.001	1.37±0.06
	30-45	7.81±0.12	0.25±0.01	0.16±0.001	1.49±0.05
	45-60	7.97±0.10	0.13±0.02	0.19±0.008	1.53±0.09
Prosopis juliflora	0-15	7.65±0.04	1.02±0.02	0.14±0.002	1.09±0.03
	15-30	7.76±0.13	0.60±0.01	0.15±0.001	1.17±0.05
	30-45	7.90±0.17	0.45±0.01	0.17±0.003	1.29±0.05
	45-60	8.11±0.12	0.28±0.03	0.22±0.0014	1.31±0.06
Dendrocalamus hamiltonii	0-15	7.46±0.09	0.93±0.01	0.08±0.001	1.12±0.04
	15-30	7.74±0.07	0.52±0.02	0.09±0.001	1.30±0.06
	30-45	7.88±0.14	0.40±0.01	0.10±0.002	1.39±0.08
	45-60	8.06±0.17	0.22±0.03	0.13±0.009	1.43±0.05

Some medicinally important plant species in three tree plantations were; *Gloriosa superba, Adhatada zeylanica*, *Abrus precatorius, Barleria prionitis, Tinospora cordifolia, Eclipta alba, Ziziphus oenoplia*, *Cardiospermum halicacabum* and *Commenlina benghalensis.* The plantations of *Eucalyptus tereticornis* and *Dendrocalamus hamiltonii* were found to provide suitable habitat for viable population of *Gloriosa superba*, a critically endangered plant species.

Analysis of Soil Aggregate Composition and Clay Mineralogy: The sub-samples of replicated field moist soil samples (0-15 cm, 15-30 cm, 30-45 and 45-60cm soil depth) were gently crumbled manually and sieved (>8mm) to remove root and were air dried for analysis of soil aggregates.

The soil aggregate size classes were studied using the wet sieving method [10]. Soil aggregates were wet sieved into four size classes (>2mm, 2mm-250µm, 250µm-53µm and <53µm) by using sub samples of soil. The sub samples of aggregate size fractions were oven dried at 80°C to represent the aggregate soil weight on oven dry weight basis.

The <2µm clay fraction that was wholly separated from the soil was used to examine the clay mineralogical composition by the X-ray diffraction (XRD) method. Oriented separated clay samples were prepared to determine the clay mineral constituents. Glycolated treatment was made for each sample. The XRD analysis was performed using XPERT-PRO model diffractrometer with Cu as anode material using CuKα radiations at 45KV and 40mA and at a scanning speed of 0.017 in a continuous scanning mode over a range of the 2θ range 4º to 40º (untreated samples) and 4° 2θ to 60° 2θ position (glycolated samples). Relative mineral contents in clay fractions were semi quantitatively estimated on the basis of XRD peak intensities by assuming the relative proportion of the minerals of samples normalized to 100% and the same proportionality between the peak intensity and the content for each mineral.

Analysis of Soil Organic and Inorganic Carbon: Sub-samples of air-dried soil and separated soil aggregates were analyzed for organic carbon by dichromate oxidation method [11]. The amount of organic and inorganic carbon in soil was estimated from the bulk density, soil depth and organic and inorganic carbon concentration in soil of the respective soil depth.

Statistical Analysis: Data on soil carbon, soil aggregates and soil aggregates carbon were analyzed using one way analysis of variance. Least significant difference (LSD) values at the 5% levels of significance ($p \leq 0.05$) were calculated following Gomez and Gomez [12].

RESULTS AND DISCUSSION

Soil Organic Carbon: In different tree plantations, soil organic carbon showed marked decrease with increase in soil depth (Fig. 1). In tree plantations, the total soil organic carbon was 31.857 Mg C ha^{-1} in *Eucalyptus tereticornis* 41.416 Mg C ha^{-1}in *Prosopis julflora* and 38.823 Mg C ha^{-1} in *Dendrocalamus hamiltonii* plantation. In *Eucalyptus* tereticornis plantation the soil organic carbon (Mg C ha^{-1}) was: 13.627 (0-15cm), 9.658 (15-30cm), 5.587 (30-45cm) and 2.983 (45-60cm). In *Prosopis julflora* plantation, the soil organic carbon (Mg C ha^{-1}) was: 16.677 (0-15cm), 10.530 (15-30cm), 8.707 (30-45cm) and 5.502 (45-60cm). In *Dendrocalamus hamiltonii* plantation the soil organic carbon (Mg C ha^{-1}) was: 15.624 (0-15cm), 10.140 (15-30cm), 8.340 (30-45cm) and 4.719 (45-60cm). The carbon stock at 0-30cm soil depth was 65-73% of the total organic carbon stock up to 60cm soil depth. Stock of organic carbon present in natural soils represents a dynamic balance between the output of organic plant residues and loss of carbon in litter decomposition.

Soil Inorganic Carbon: Surface layer of soil was found to store less inorganic carbon as compared to sub-surface layers. The total inorganic carbon was greater in *Prosopis julflora* plantation (12.534 Mg C ha^{-1}) as compared to *Eucalyptus tereticornis* (13.056 Mg C ha^{-1}) and *Dendrocalamus hamiltonii* (7.972 Mg C ha^{-1}) plantations. In *Eucalyptus tereticornis* plantation, the soil inorganic carbon (Mg C ha^{-1}) was: 2.242 (0-15cm), 2.877 (15-30cm), 3.576 (30-45cm) and 4.360 (45-60cm). In *Prosopis julflora* plantation, the soil inorganic carbon (Mg C ha^{-1}), was: 2.289 (0-15cm), 2.632 (15-30cm), 3.289 (30-45cm) and 4.323 (45-60cm). In *Dendrocalamus hamiltonii* plantation, the soil inorganic carbon (Mg C ha^{-1}) was: 1.344 (0-15cm), 1.755 (15-30cm), 2.085 (30-45cm) and 2.788 (45-60cm). However, most of soil inorganic carbon was found below 30cm soil depth in different plantations (Fig. 2).

The largest amount of soil inorganic carbon (SIC) is present in the form of soil carbonates [13] and the account for one third of the total carbon in soil at different soil depth. The Soil inorganic carbon stock has the potential

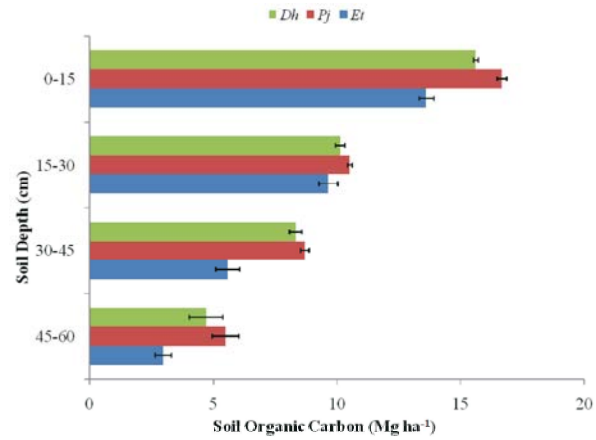

Fig. 1: Soil organic carbon (Mg C ha^{-1}) in different tree plantations, at Seonthi Reserve Forest, Kurukshetra.

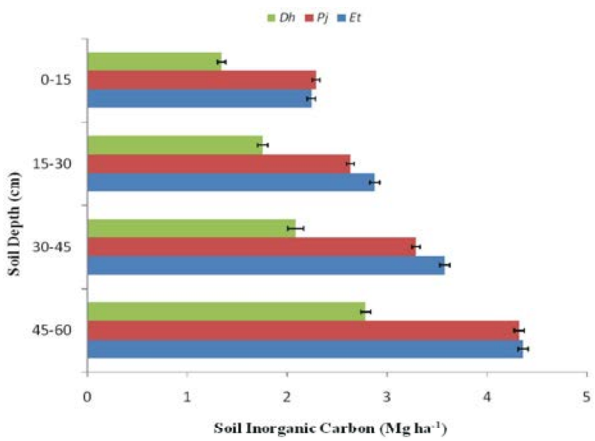

Fig. 2: Soil inorganic carbon (Mg C ha^{-1}) in different tree plantations, at Seonthi Reserve Forest, Kurukshetra.

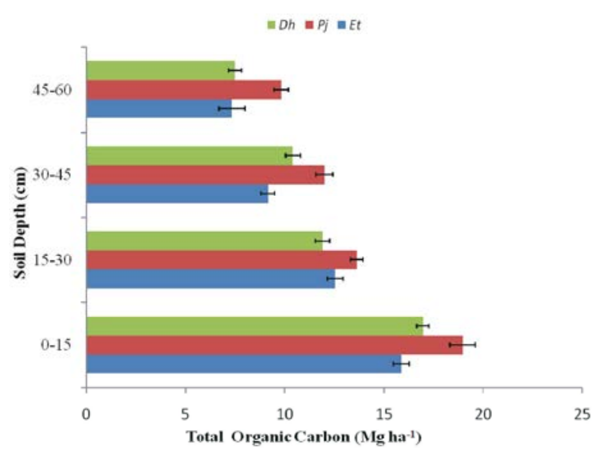

Fig. 3: Total soil carbon (Mg C ha^{-1}) in different tree plantations, at Seonthi Reserve Forest, Kurukshetra.

to help in the establishment of vegetation as well as sequestration of organic carbon in the soils [14]. Pal *et al*. [15] have reported that there is large potential of sequestration of atmospheric CO_2 in the form of soil inorganic carbon i.e. pedogenic carbonates

Total Soil Carbon Stock: The largest increase in soil inorganic carbon was observed at 45-60cm soil depth in three tree plantations (Fig. 3). Total carbon stock in *Eucalyptus tereticornis, Prosopis julflora* and *Dendrocalamus hamiltonii* plantations across different soil depth was (Mg C ha^{-1}): 15.870 to 16.968 (0-15cm), 11.895 to 13.162 (15-30cm), 9.163 to 11.997 (30-45cm), 7.344 to 9.825 (45-60cm).

Soil Aggregate Composition and Carbon Storage: In the three tree plantations, only a small amount of macroaggregates (2mm-250µm) were recovered from soils up to 0-30cm soil depth (Table 2). The proportion of large macroaggregates (>2mm) was higher in the case of *Eucalyptus tereticornis* (2.87%) and lowest in the case of *Prosopis juliflora* (1.28%) The amount of small macroaggregates ranged from 2.80% to 24.93% in different plantations. In contrast, microaggregates (250µm-53µm) varied from 27.02% to 29.84% in *Eucalyptus tereticornis*, 32.50% to 39.78% in *Prosopis juliflora* and 27.96% to 43.53% in *Dendrocalamus hamiltonii,* plantation. The silt and clay (<53µm) associated aggregates formed large fraction of soil aggregates and the values varied from 45.06% to 54.02% in *Eucalyptus tereticornis*, 41.75% to 43.25% in *Prosopis juliflora* and 52.30% to 54.20% in *Dendrocalamus hamiltonii.*

The carbon concentration was higher in macroaggregates (2mm-250µm) as compared to microaggregates (250µm-53µm) (Table 3). The carbon concentration in macroaggregates (2mm-250µm) varied from 0.25 to 0.93% in *Eucalyptus tereticornis;* 0.17 to 0.98% in *Prosopis juliflora;* 0.27 to 1.03% in *Dendrocalamus hamiltonii.* The concentration of carbon in microaggregates (250µm-53µm) ranged from 0.20 to 0.87% in *Eucalyptus tereticornis* plantation*,* 0.14 to 0.89% in *Prosopis juliflora* and from 0.21 to 0.85% in *Dendrocalamus hamiltonii* plantation. In the silt and clay fractions (<53µm) carbon concentration was: 0.12 to 0.61% *Eucalyptus tereticornis* plantation; 0.10 to 0.71% *Prosopis juliflora;* 0.16 to 0.58% *Dendrocalamus hamiltonii.* The differences in organic carbon storage in soil aggregates could be attributed to organic matter

Table 2: Percent soil weight distribution in aggregate size classes in tree plantations of *Eucalyptus tereticornis, Prosopis juliflora* and *Dendrocalamus hamiltonii* across soil depth at Seonthi Reserve Forest, Kurukshetra

Tree plantation	Size classes			
Soil Depth (cm)	>2mm	2mm-250 µm	250-53 µm	<53µm
Eucalyptus tereticornis				
0-15	2.87±0.13	24.48±2.21	27.59±2.23	45.06±2.35
15-30	1.36±0.13	17.94±3.49	29.84±1.14	50.88±2.47
30-45	1.29±0.27	18.30±1.61	27.02±2.55	53.44±1.26
45-60	0.92±0.12	16.91±1.21	28.15±2.74	54.02±1.37
CV (%)	22.53	17.12	9.55	6.56
LSD ($P \leq 0.05$)	0.57	5.55	4.39	5.38
Prosopis juliflora				
0-15	1.28±0.13	18.62±2.50	39.78±3.05	42.25±4.74
15-30	0.9±0.23	18.74±2.13	37.92±2.50	42.60±2.53
30-45	0.75±0.04	24.93±2.46	32.50±2.51	41.75±2.09
45-60	0.53±0.06	22.18±1.13	34.04±1.89	43.25±1.72
CV (%)	28.28	14.79	8.00	7.59
LSD ($P \leq 0.05$)	0.40	5.18	4.69	5.21
Dendrocalamus hamiltonii				
0-15	2.67±0.27	15.52±0.67	27.96±0.62	53.85±2.61
15-30	0.73±0.05	4.81±0.14	40.90±3.05	54.20±1.66
30-45	0.57±0.03	3.90±0.39	43.24±2.79	52.30±1.31
45-60	0.29±0.17	2.80±0.22	43.53±1.26	53.38±1.53
CV (%)	22.46	10.91	10.64	6.63
LSD ($P \leq 0.05$)	0.39	1.19	6.74	5.77

Table 3: Soil organic carbon concentration in aggregate size classes in tree plantations of *Eucalyptus tereticornis, Prosopis juliflora* and *Dendrocalamus hamiltonii* across soil depth at Seonthi Reserve Forest, Kurukshetra

Tree plantation	Size classes		
Soil depth (cm)	2mm-250 µm	250-53 µm	<53µm
Eucalyptus tereticornis			
0-15	0.93±0.06	0.87±0.08	0.61±0.06
15-30	0.62±0.04	0.52±0.01	0.41±0.03
30-45	0.52±0.03	0.41±0.03	0.26±0.02
45-60	0.25±0.02	0.20±0.01	0.12±0.011
CV (%)	5.27	6.34	7.32
LSD($P \leq 0.05$)	0.05	0.06	0.04
Prosopis juliflora			
0-15	0.98±0.08	0.89±0.07	0.71±0.07
15-30	0.73±0.06	0.62±0.06	0.49±0.05
30-45	0.31±0.03	0.29±0.04	0.21±0.01
45-60	0.17±0.017	0.14±0.014	0.10±0.015
CV (%)	4.79	5.82	5.85
LSD($P \leq 0.05$)	0.04	0.05	0.04
Dendrocalamus hamiltonii			
0-15	1.03±0.09	0.85±0.08	0.58±0.06
15-30	0.79±0.08	0.58±0.06	0.48±0.05
30-45	0.56±0.06	0.44±0.03	0.33±0.02
45-60	0.27±0.03	0.21±0.01	0.16±0.01
CV (%)	4.85	6.64	4.57
LSD($P \leq 0.05$)	0.05	0.05	0.03

inputs into the soil, relative decomposition rates of litter and fine roots and clay and silt content of soil. It is interesting to note that clay and silt content of soils showed increase with increase in soil depth.

Soil aggregates are the basic unit of soil structure influencing many physical and biological processes of the soil. Soil aggregates is an important process of carbon sequestration [16]. In the studied tree plantations, it was found that organic carbon concentration decreased from macroaggregates to microaggregates at various soil depths. The soil macroaggregates are stabilized mainly by recently deposited residues and carbohydrate rich root or plant debris occluded within aggregates [17]. Silt plus clay fraction in soil play a key role in the protection of soil organic matter [18].

Macroaggregates are sensitive to soil disturbance, but microaggregtes are generally more stable and resistance to disturbance. The soil organic carbon in microaggregates is believed to be protected from degradation and is relevant for soil carbon sequestration. Loss of carbon from macroaggregates is more rapid than microaggregates due to lower protective effects of biophysical and chemical processes [19].

Clay Mineralogy: X-ray diffraction is the most common technique used to study the characteristics of crystalline structure and to determine the mineralogy of finer grained sediments, especially clays. X-ray diffraction analysis is a useful method to identify and to make semi quantitative estimates of the crystalline mineral components of soil. Angles of diffraction, as affected by differentiating sample treatments, are distinctive for a particular mineral and help to identify that mineral. Intensities of diffraction maxima are related to the number of corresponding diffraction planes in a sample and provide a basis for the estimation of concentrations of the mineral species present.

The XRD pattern of the glycolated samples of soil in three tree plantations at Seonthi Reserve Forest, Kurukshetra are shown in Figures 4, 5 and 6. The clay fraction is dominated by Illite, which was identified by the presence of 3.35A° peak along with its higher order reflection at 10.08A° and 4.97A°. The presence of Chasmosite was ascertained by the relative sharp peaks at 7.19A° in glycolated sample. The presence of Montmorillonite, Dickite, Chlorite, Vermiculite, Muscovite and Palygorsite was confirmed by basal reflection at 4.49A°, 4.26Å, 3.52A°, 3.50 Å, 3.20 Å, 4.25 Å, Kaolinite 2.38Å and Feldspar at 2.98 Å.

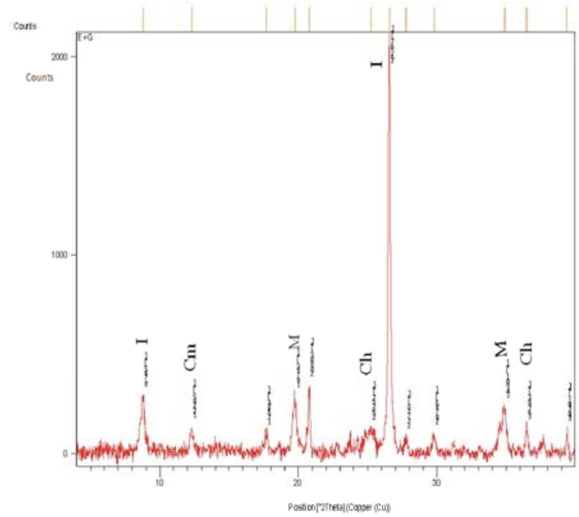

Fig. 4: X-ray diffraction pattern of glycolated clay sample of 25 year old *Eucalyptus tereticornis* plantation at Seonthi Reserved Forest, Kurukshetra (I=Illite, Cm=Chasmosite, M=Montmorillonite, Ch=Chlorite)

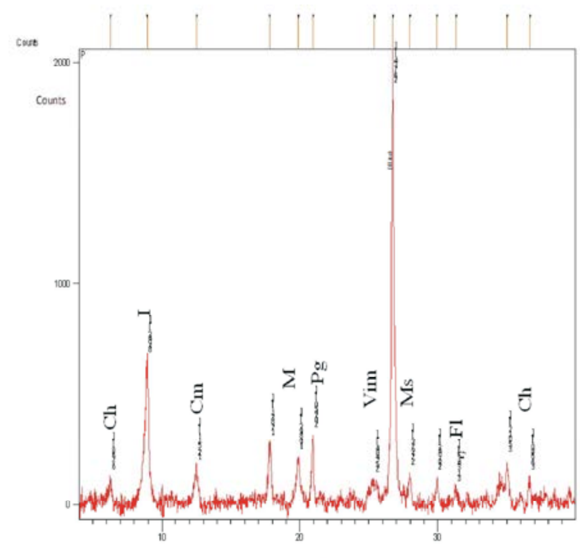

Fig. 5: X-ray diffraction pattern of glycolated clay sample of 25 year old *Prosopris juliflora* plantation at Seonthi Reserved Forest, Kurukshetra (I=Illite, Cm=Chasmosite, M=Montmorillonite, Ch=Chlorite, Pg= Palygorsite, Vm= Vermiculite, Ms= Muscovite, Fl= Feldspar)

In this study, the illite and montmorillonite (a member of the smectite family, 2:1 clay) were predominant in the soil. Gonzalez and Laird, [20] while studying the

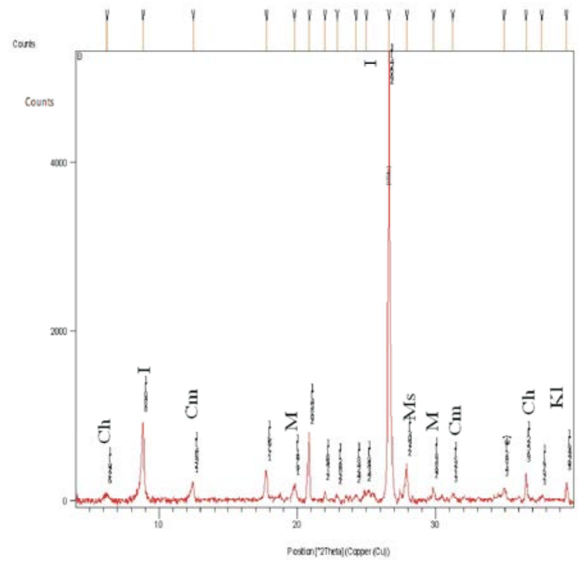

Fig. 6: X-ray diffraction pattern of glycolated clay sample of 10 year old *Dendrocalamus hamiltonii* plantation at Seonthi Reserved Forest, Kurukshetra (I=Illite, Cm=Chasmosite, M=Montmorillonite, Ch=Chlorite, Ms= Muscovite, Kl= Kaolinite)

distribution of newly formed humic materials into mineralogical distinct clay size fractions on a silt loam soil showed that new humic materials are preferentially accumulated on smectite surfaces. In this study, the predominance of illite and montmorillonite in the clay could play an important role in soil carbon stability. The association of organic matter in soil with minerals is a controlling factor of C storage in soil.

The stabilization of organic material by soil matrix is a function of chemical nature of mineral fraction and its surfaces capable of adsorbing the organic material [21].. In arid and semi-arid regions, smectite, chlorite, illite, kaolinite and vermiculite are the dominant clay minerals [20]. The concept of clay organic complex formation in soil is interesting, which regulates soil quality and determines soils to be a net sink and source of carbon

CONCLUSION

Tree plantations have potential in carbon sequestration by improving soil structure and increasing soil carbon in various soil aggregate fractions. Tree plantations on degraded lands could be effective strategy for forest restoration and carbon sequestration over short-and long-term. In the tree plantations soil, microaggregates (250µm-53µm) and clay and silt associated soil fractions (<53 µm) formed a large fraction of soil aggregates and protected most of soil organic carbon in the soil. In this study, the predominance of illite and montmorillonite in the clay could play an important role in soil carbon stability. Fractions rich in Kalonite often showed less carbon contents, while the smectite rich fractions contain organic carbon within a wide range. The processes of formation and properties of clay organic complexes may facilitate development of forestry and agricultural systems that increase long term C stability or sequestration in soils.

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