Soil Microbial Biomass Carbon in Tree Plantations of Kurukshetra University, Kurukshetra

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Abstract – Soil Microbial Biomass (SMB) is a living and active component of soil organic matter. It serves as a major source of available nutrients to plants and these nutrients are liberated after the death of micro-organisms. The microbial carbon is an important functional part of soil organic carbon, which provides the main carbon-dioxide production by soils. The present study was done to estimate the soil microbial biomass carbon and nitrogen in tree plantations at Kurukshetra University, Kurukshetra which comprise pure plantations of Tectona grandis, Eucalyptus tereticornes and Syzygium cumini. MB-C shows decrement with increase in soil depth from 0-30cm in both winters and summers. Higher amounts of Microbial Biomass were observed in winter season as compared to summer for all species. The soil microbial biomass carbon was highest in soil of Tectona grandis followed by Syzygium cumini. The least amount was found in Eucalyptus tereticornes

Key words: microbial biomass carbon, tree plantations, soil organic matter

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INTRODUCTION:

Soil microbial biomass is a living pool containing 1-5% of the soil organic matter (Jenkinson & Ladd, 1981; Sparling, 1992), excluding root, meso- and macro-fauna. It is both a source and sink of available nutrients for plants and plays a critical role in nutrient transformation in terrestrial ecosystems (Singh *et.al.,*1989). It is influenced by seasonal moisture and temperature fluctuations, addition of organic matter and tillage management (Dalal *et.al.,* 1991; Lindquest *et.al.,*1999). Generally, microbial biomass can offer a means in assessing the soil quality in different vegetation types (Groffman *et.al.,* 2001; Zeng *et.al.,* 2009). It can be also used for evaluating soil perturbation and restoration (Ross *et.al.,* 1982; Smith and Paul, 1990).

The microbial biomass is responsible for the decomposition of soil organic matter, releasing nutrients in inorganic forms that are later absorbed by plant roots (Devi & Yadava, 2006). Forest types influence soil microbial biomass and activities by determining the quantity and quality of organic matter inputs (Hackl *et.al.,* 2004; Xu *et.al*., 2008). Besides forest types, seasonal variations of temperature, rainfall, plant development, and organic matter accumulation from litterfall also have great influences on soil microbial biomass (Chen *et.al.,* 2005; Devi and Yadava 2006; Maithani *et.al.,* 1996; Tonon *et.al.,* 2005). High amounts of organic inputs often result in high microbial biomass (Flieβbach and Mäder 2000).

Microbial biomass carbon, which is defined as the carbon present in a system produced by microorganisms, has been used as an indicator of ecosystem dynamics and stability (Insam 1990, Rosacker and Kieft 1990, Wardle 1992, Bolton et al. 1993, Gallardo and Schlesinger 1995). The microbial carbon is an important functional part of soil organic carbon. It is a common soil parameter used to evaluate microbial abundance in soil environments.

The present study aims to determine the amount of soil microbial biomass carbon in three types of tree plantations comprising *Eucalyptus tereticornes, Tectona grandis* and *Syzygium cumini* in Kurukshetra University, Kurukshetra, Haryana.

MATERIAL AND METHODS

Study Site:

Kurukshetra district lies between latitude 29°-52' to 30°-12' and longitude 76°-26' to 77°-04' in the North Eastern part of Haryana State. The climate of the district is of pronounced character i.e. very hot in summer and markedly cold in winter. It is as high as 45º C in summer and as low as 3º C in winter. The normal annual rainfall of the district is 582 mm which is unevenly distributed over the area. The study sites, located in Kurukshetra University, Kurukshetra include pure plantations of *Tectona grandis, Eucalyptus tereticornes* and *Syzygium cumini.*

Soil Sampling:

A 20 x 20 meter quadrat was marked in each site and five points were identified (four corners and one at centre) for soil collection. Soil was sampled using soil corer from up to 30 centimeter depth (0-5cm, 5-15cm and 15-30 cm) in winter and summer season (December, 2010 and April, 2011). The litter layer was removed prior to sampling. The samples were collected in marked polythene bags and tightly closed to prevent any air exchange. Some samples were procured for immediate moisture content measurement while others were stored at 4^0C prior to analyze the microbial biomass.

Soil Analysis

Soil samples were analyzed for moisture content using Moisture Meter (IR 60, Denver Instruments). Soil pH was measured for a 1:2 solution of soil sample in distilled Water. Soil Microbial biomass carbon was measured by following the method of Nunan, 1998. Freshly removed soil (17.5 gm) was taken in Schott Bottle and fumigated with chloroform. One set was maintained without fumigation. The soil samples were incubated in dark for 24 hours. After incubation the bottle was placed in fume hood for 30 minutes, until the chloroform evaporated completely and 0.5M potassium sulphate (70ml) was added to both fumigated and unfumigated samples. The bottles were shaken in an end to end shaker for 30 minutes. The extract was filtered through whatmann filter paper no. 42. Optical density of the fumigated and unfumigated extract was measured using aliquots of potassium sulphate extract through dichromate digestion method. Microbial biomass carbon was calculated after back titration with ferrous ammonium sulphate using the equation:

Biomass Carbon = 2.64 * E_C

E_C = Org. C from fumigated soil – Org. C from non-fumigated soil.

RESULTS:

In all the three plantations, moisture content increased down the depth in both the months i.e., December and April. Soil was moister in summer than winter, however, highest moisture content was observed on the soil of *S. cumini* followed by that of *T. grandis and E. tereticornes.* The values for pH increased down the depth and was higher in the winter season in all the tree plantations. The pH was observed to be slightly alkaline to alkaline. The highest values were observed in *E. tereticornes* (Table 1)

Table 1: Mean of % moisture content and pH in soil of tree plantations at different depths in winter and summer season. Values after ± represent Standard Deviation.

Parameter	Season	Depth(cm)	*T. grandis*	*E. tereticornes*	*S. cumini*
% moisture content	winter	0-5cm	1.76	1.63	2.87
		5-15cm	2.81	2.68	3.48
		15-30cm	4.21	3.12	4.39
	summer	0-5cm	2.62	2.21	3.16
		5-15cm	3.37	3.07	3.94
		15-30cm	4.28	4.19	4.97
pH	winter	0-5cm	7.91±0.05	8.33±0.08	8.18±0.10
		5-15cm	8.08±0.05	8.44±0.01	8.13±0.14
		15-30cm	8.01±0.07	8.28±0.10	8.32±0.03
	summer	0-5cm	7.46±0.33	8.07±0.08	7.62±0.03
		5-15cm	7.66±0.09	8.36±0.01	7.63±0.01
		15-30cm	7.71±0.03	8.52±0.01	7.79±0.03

Soil Microbial Biomass Carbon

Microbial Biomass Carbon in Soil decreased with increase in depth. MB-C was very high in soil from 0-5 cm depth and showed a sharp decrease with increase in depth from 5-15 to 15-30cm. It may be due to high organic matter content in upper layers of soil by leaf litter, plant residues and rhizospheric roots which adds carbon regularly and it gets decomposed by the soil micro-organisms. Among the sites, the highest MB-C was observed in the soil of *Tectona* followed by *S. cumini* and *E. tereticornes* (Table 2).

Table 2: Microbial Biomass Carbon (µg C g^{-1} of soil) of five tree plantations at different depths in winter and summer Season. Values after ± represents standard deviation

	Depth(cm)	*T. grandis*	*S. cumini*	*E. tereticornes*
winter season	0-5cm	182±0.77	179±0.22	104±0.09
	5-15cm	129±0.06	101±0.05	78±0.07
	15-30cm	87±0.06	58±0.02	32±0.06
summer season	0-5cm	88±0.20	70±0.02	62±0.02
	5-15cm	74±0.05	54±0.01	28±0.02
	15-30cm	59±0.01	43±0.02	16±0.01

Seasonal variations of soil microbial biomass reflect the degree of immobilization–mineralization of soil carbon. A decrease in soil microbial biomass can result in mineralization of nutrients, whereas an increase in

microbial biomass may lead to immobilization of nutrients (McGill et al. 1986).

DISCUSSION

Results in this study indicate that the two stand types differ markedly in soil microbial biomas carbon. Many factors have been suggested to explain the effects of vegetation type on microbial biomass in soils (Hackl et al. 2004) like differences in the quantity and quality of substrate inputs via varying litter and root types and associated nutrient specificity can be crucial drivers to influence the soil microbial biomass (Feng et al. 2009; Jin et al. 2010). Thus, the higher MBC in *Tectona* stand is mainly attributable to the greater availability of organic matter than other plantations. Amount of litter fall also reduces in the summer season. The rise in temperature together with the reduced input of carbon causes a decline in SOC including microbial biomass carbon thus accounting for higher amount of MBC in winter than in summer season (Pandey *et.al.,* 2010).

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