Investigating Variation of Microbial Biomass in Plantation Forests with Age

M.M.S.N. Premetilake
Uva Wellassa University, Badulla, Sri Lanka

R.R. Rathnayake, S.A. Kulasooriya
Institute of Fundamental Studies, Kandy, Sri Lanka

and

G.A.D. Perera
University of Peradeniya, Sri Lanka

Introduction

Soil organic carbon is the basis of sustainable agriculture and is important for chemical, physical and biological fertility. Consequently, carbon soil fertility could be improved more via sequestering. The role of microorganisms is important for carbon sequestration in soil compared to other factors. Thus, by increasing the activity of microorganisms we can increase carbon sequestration and soil fertility.

Plantation forests were originally established in Sri Lanka to provide industrial timber and fuel wood. There are also other uses such as wind protection, bee keeping and oil extraction and moreover they provide invaluable ecosystem services. At present, sites available for reforestation in Sri Lanka are generally poor in nutrients and fertilizer application is required for better growth of seedlings.

A novel approach of research at the IFS is the application of beneficial microbial consortia as biofilm biofertilizers for sustainable agriculture (Seneviratne *et al.*, 2011). These are low cost and are eco-friendly. The shifts in composition and function of the microbial community in response to different stages of forest regeneration play an important role in determining rates of C changes (loss or gain) in the soil (Plante *et al.*, 2005). Hence the long term goal of this study is to produce biofilm biofertilizer for forest plantations to improve their yields. This would be more beneficial, less expensive and have no detrimental effects to the ecosystems. The biofilm biofertilizer will be prepared using the microorganisms that have the capability of sequestering more carbon than the others. In this process, identification of the microorganisms and the factors affecting them is a crucial component. There are no studies conducted on this regard in Sri Lankan plantation forests yet. In the current study we investigated how the microbial biomass carbon (MBC) varies in *Eucalyptus grandis* forests in Sri Lanka with their age. Improved Carbon sequestration in forests would deliver better yields and would assist in minimizing climate change and support in obtaining foreign currency via carbon trading.

Methodology

Eucalyptus grandis forest plantation sites of four different age groups having similar characteristics were selected for this study. Three plots each of 20 m x 20 m size were demarcated in each site and each plot was divided into four sub plots. Systematic soil sampling was carried out by accumulating 36 samples from each plot. Soil was collected from two depth levels (0-15 cm and 15- 30 cm) by using a soil auger with 5 cm diameter.

MBC was extracted using chloroform fumigation method and then measured using titration method (Anderson and Ingram, 1998).Statistical analysis was carried out using MINITAB version 16.

Results

MBC in plantation forests varied significantly ($P < 0.05$) with their age (Figure 01) but there was no significant difference between the MBC of the two layers ($P > 0.05$).

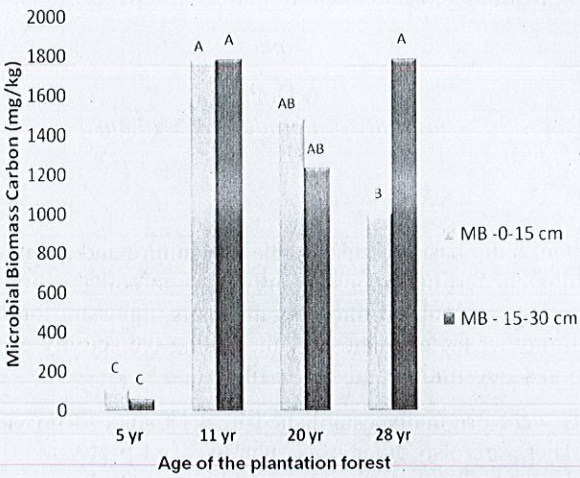

Figure 01: Variations in MBC with age of the plantation

When mean values are compared by Tukey test, 11 year old site showed the highest amount of microbial biomass carbon (MBC) for both layers, while the youngest site of 5 years had the lowest. Microbial biomass carbon increased in both layers after five years and reached a maximum at the age of 11 years. After 11 years there is a decrease in mean values of microbial biomass carbon in both layers. The microbial biomass in 15-30 cm layer however, has increased again rapidly after 20 years.

Discussion

The disturbance of soil affects soil organic carbon severely and thereby the microbial biomass carbon. The initial disturbance at the time of establishment leads to a decline of organic carbon in surface soil. The decline usually continues for a period of about five years (Turner and Lambert, 1999). The low microbial biomass carbon demonstrated by the youngest site could be due to this reason. There was a rapid increase in MBC in the 11 years old plantation in both layers. Subsequently in the surface soil layer (0-15 cm) MBC decreased rapidly. Monoterpene is one of the major chemicals released by *Eucalyptus* trees andi it has been recorded that the existence of microbial and/or invertebrate decomposers is inhibited by either individual monoterpenes or combinations (White, 1994). The reason for decline in MBC in older forest may be due to the effect of monoterpenes in litter and soil. Furthermore, it has been reported that the age of trees have an influence on the terpene emission rates and total monoterpene emission rates from older trees are higher than those from the younger trees (Kim *et al.*, (2005). This may explain the decline of MBC in surface soil layer with their age after 11 years. However, there was no significant difference in MBC between the two layers (0-15 cm and 15-30 cm). These results may be due to the climatic factors but further analysis should be carried out to verify it.

Conclusions

Microbial Biomass Carbon in surface soils increased rapidly after five years of plantation and reached its maximum value after eleven years. Therefore, when extracting soil samples to isolate microorganisms for the production of biofilm biofertilizer it is convenient to use soils from plantations around this particular age group for better results.

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