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Short Communication

Influence of Leaf Litter Decomposition on Carbon Mineralization in a Jhumland and a Forest

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ABSTRACT

Tthe influence of decomposition of tree litter on C- mineralization in soil was investigated in a jhumland and a forest area in Tanhril, about 17 km west of Aizawl (NE India). Two types of dominant tree species were selected: *Albizia chinensis* and *Callicarpa arborea* in jhumland and *Schima wallichi* and *Anogeisus acuminata* in the forest site. The study was conducted on three types of slopes: 6-10 % (gentle), 15-25% (moderate) and 25-35 % (steep), in each of the study site. Leaf litter decomposition was studied by litter bag method. Soil samples were also collected from the area after the litterbags were picked up every month. At both the sites, decomposition of leaf was high in the moderately sloped area. The rate of decomposition of *Callicarpa arborea* is faster than *Albizia chinensis* in the jhumland. In the forest area, *Anogeisus acuminata* litter decomposed faster than that of *Schima wallichi*. The rate of C-mineralization corresponded with the rate of litter decomposition i.e., higher in moderately sloped area in both sites and higher under *Anogeisus acuminata* in the forest.

Key Words: Biomass; Elevation; Jhum Cultivation; Litterbags; Slope Angle; Soil Respiration

INTRODUCTION

Decomposition of organic matter is largely a biological process that occurs naturally in soil. Its rate is determined by three major factors: soil organisms, physical environment and the quality of the organic matter (Brussaard 1994). During the decomposition process, different products are released: carbon dioxide (CO_2), energy, water, plant nutrients and resynthesized organic carbon compounds. Soil organisms, including microorganisms, use soil organic matter as food. As they break down the organic matter, excess nutrients (N, P and S) in their inorganic forms are released into the soil so that plants can utilize them as well as CO_2 through their respiration. This release process is called mineralization. These two processes of decomposition and mineralization are vital for all types of ecosystems. In North East India, especially in Mizoram, forest cover is high as well as conversion of forest area into agricultural fields mainly through jhumming cultivation (shifting cultivation) is high. Currently, the fallow period has decreased to 3 to 5 years from 10-25 years in the past due to increase in demand for more food. Therefore, the present study was undertaken to study the rate of decomposition of two dominant tree species in a jhumland and a forest and to estimate its influence on the rate of carbon mineralization on different slopes.

MATERIALS AND METHODS

Study Sites

The forest site was selected in a tropical semi evergreen type of forest within Mizoram University Campus. A seven years old jhumland where different types of

vegetables like mustard plant and wild lemon are still cultivated was also selected in an adjacent plot outside the campus. Both sites are located in the same place. Tanhril, which is about 17 km west of Aizawl. The area of Mizoram University campus is 978 acres (407 ha) and it lies between 23° 43' 25" to 23° 45' 37" N and 92° 38' 39" to 92° 40' 23" E. Three types of slopes: 6-10 % (gentle), 5-25% (moderate) and 25-35 % (steep) were selected at both the sites. The elevation of plots in the jhumland and forest ranges from 400 to 500m and 600 to 700 m above sea level, respectively. In the jhumland few trees were found. Two dominant tree species in each site were selected: *Albizia chinensis* and *Callicarpa arborea* in jhumland and *Schima wallichi* and *Anogeisus acuminata* in the forest site.

The climate of the area is monsoonal with warm moist summer and cool dry winter. The mean maximum temperature varies from 16.00 °C to 24.00°C and the mean minimum temperature ranges from 4.00°C to 17.00°C.The mean monthly rainfall ranges from 6.2 mm to 417.4 mm. The average annual rainfall is 2187mm.

Decomposition

10×10 m fixed plots were established in each slopes in both the sites. Litterbag technique outlined by Anderson and Ingram (1993) was used to study leaf litter decomposition. Nylon bags measuring 20 x 20 cm with mesh size of 1.2 mm was prepared. Freshly fallen leaf litter of the selected species was collected from the sites. The litter was air dried till constant weight. Ten grams of litter of each of the species were put into each nylon bag. A total of 216 litter bags for each species were prepared and 36 bags for each species were put in each plot at the two sites during July 2013. Three bags for each species were picked up every month from August 2013 onwards for the study of decomposition pattern. The litter bags were fixed to soil with small bamboo cuttings so that they are not moved away by wind or water.

C-Mineralization

Mineralisation of C was estimated monthly by following incubation methods outlined by Anderson and Ingram (1993). Soil samples were collected from beneath the litterbags in order to study the changes in C-mineralization in soil due to presence of the litter which can be regarded as a type of surface treatment. CO_2 evolved from the soil was measured by keeping 200g of soil in a glass jar. Small vials containing 20 mL of 0.1N KOH was placed inside the jar and sealed airtight and kept for 24 hours. The vials were removed and titrated with 0.1N HCl in order to determine the amount of CO_2 evolved. C mineralization was calculated from the difference between the CO_2 produced by the soil collected beneath litterbags and that produced in the same period by the soil without the litter (control soil). The method is followed from various workers in different ecosystems (Jin et al. 2008, Morvan and Nicolardot 2009).

RESULTS

The rate of decomposition of the different types of litter and the changes in the C-mineralization due to the litter are given in Figures 1-8. It is observed that the weight loss pattern in *C. arborea* was almost similar at all the slopes upto the eighth month. From April 2014 when rains started, the weight loss rate was faster with a more rapid rate on the steep sloped site attaining upto 75% loss of weight and 65% and 62% in the moderate and gentle slopes respectively.

In the soil under *C. arborea* litter, the increase in rate of C-mineralization on the moderate slope maintains relatively an uniform sequence whereas on the other two slopes there was lot of variation up to the eighth month. However, from ninth month onwards there was an increasing trend on all the slopes. Overall increase in C-

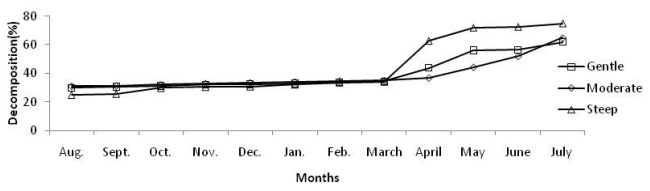

Figure 1. Rate of decomposition in *Callicarpa arborea* in jhumland in the three types of slopes.

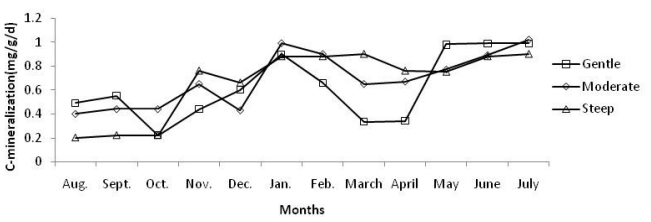

Figure 2. C mineralization in *Callicarpa arborea* in jhumland in the three types of slopes.

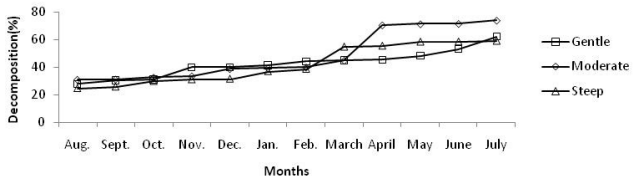

Figure 3. Rate of decomposition in *Albizia chinensis* in jhumland in the three slopes.

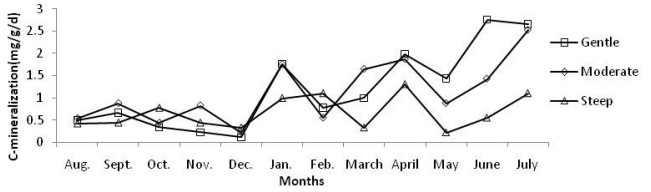

Figure 4. C mineralization in *Albizia chinensis* in jhumland in the three types of slopes.

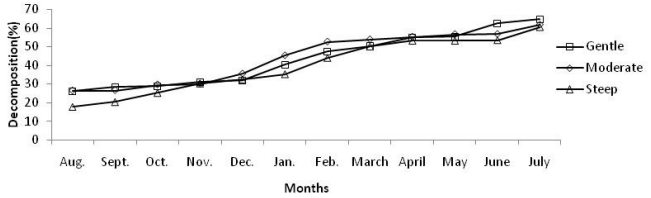

Figure 5. Rate of decomposition in *Schima wallichi* in forest in the three slopes.

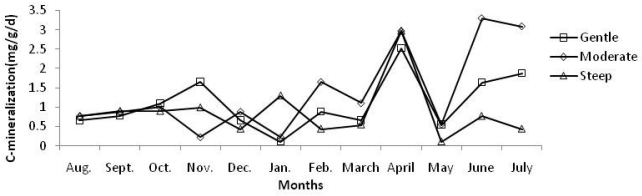

Figure 6. C mineralization in *Schima wallichi* in forest in the three slopes.

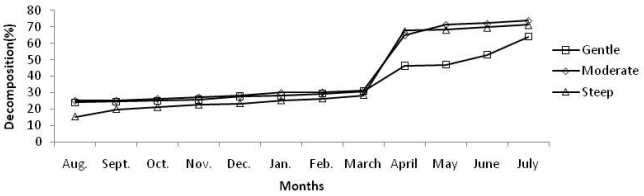

Figure 7. Rate of decomposition in *Anogeisus acuminata* in forest in the three slopes

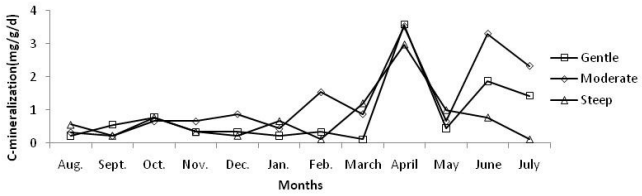

Figure 8. C mineralization in *Anogeisus acuminata* in forest in the three slopes.

mineralization rate ranged from 0.2 to 1.02 mg g^{-1} day^{-1} in the *C. arborea* treated soil in the jhumland.

The rate of decomposition of *A. chinensis* was highest in the moderate sloped plot attaining upto 74% loss of weight. Lowest rate was found in the steep sloped plot (59%). The rate of decomposition of *Callicarpa arborea* is faster than that of *Albizia chinensis.* Increase in C- mineralization fluctuates a lot but maintains a trend of least values in the steep sloped plot. Overall increase in C-mineralization rate ranged from 0.1 to 2.75 mg g^{-1} day^{-1} in the *A. chinensis*-treated soil in the jhumland. The rate of decomposition of *A. chinensis* is faster than in *S. wallichi.*

The rate of decomposition of *S. wallichi* and *A. acuminata* was fastest on the gentle sloped plots, being 64.7% and 73.7% respectively, and lowest in steep sloped (60%) and gentle sloped (64%) plots, respectively. The rate of C-mineralization was highest in the moderate sloped and lowest in the steep sloped plot for both the species indicating more accumulation of nutrients in the moderate sloped plot from the litter leading to more carbon dioxide emission from the activities of the microorganisms. The overall range of increase in C-mineralization in the forest due to surface treatment of *S. wallichi* and *A. acuminata* is 0.1to 3.0 and 0.1 to 3.6 mg g^{-1} day^{-1} respectively, indicating that higher rate of decomposition leads to more C-mineralization.

DISCUSSION

An increase in the rate of C-mineralization in later stages can be attributed to greater soil moisture with the onset of rains. Such role of moisture on C-mineralization is reported by other workers from forest and croplands (Côté et al. 2000, Leiros et al. 1999, Zhou et al.2003).

Accumulation of the mineralized nutrients from the litter in the steep plot was resultd in lower soil respiration although decomposition was faster. Higher rate of decomposition in the steep plot can be attributed to other external factors rather than the soil properties.

By comparing the two sites, decomposition of litter was faster in the jhumland though the rate of C-mineralization was higher in the forest site. The result is a proof that jhumming cultivation reduces soil nutrient content. The higher rate of decomposition in the jhumland can be attributed to factors like loss in water runoff, wind movement etc. leading to less amount of biomass retained in the soil.

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