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Short communication

Decomposition of Different Components of Muli Bamboo in Sub-Tropical Forests of Mizoram, Northeast India: Effect of Climate

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ABSTRACT
In the present study decomposition of leaf, branch, culm and sheath litter of muli bamboo (*Melocanna baccifera)* in relation to monthly average precipitation (MAP) and monthly average temperature (MAT) was assessed. It was observed that the remaining mass at 180 days was 11% in leaf, 62% in sheath, 72% in branch and 78% in culm litter. Significant positive correlation of k ($month^{-1}$) was recorded with MAT in leaf litter; with MAP in branch litter; with MAP and MAT in culm litter, however an inverse correlation with MAP in sheath litter was recorded. The negative response of sheath litter to MAP can be attributed to resistance during decomposition in the initial stage which corresponds to more rainy months.

Key words: branch, culm, leaf, rainfall, sheath.

INTRODUCTION

Bamboo covers over 30 million hectares across the tropical and subtropical regions of the world and has enormous potential for socio-economic development and environmental protection. INBAR has recognized 20 species of bamboos including *Melocanna baccifera* (muli) as high priority for international action based on relative importance, suitability for use in special circumstances like degraded lands and mountainous areas (Rao et al. 1998). Muli is the dominant bamboo in Northeastern part of India as it can colonize in different topographic features ranging from the valleys of Manipur state to moderate and steep slopes of Mizoram. It is a medium-sized, evergreen, 10-20m tall, sympodial and thin-walled (0.5-1.2cm) bamboo. Biswas et al. (1991) and Singnar et al. (2015) described growth characteristics of muli bamboo from Northeast India. Singh et al. (2022) studied laboratory and field decomposition of leaf litter of the bamboo however, very less work is reported on decomposition of the different litter components and its relationship with climatic conditions.

Decomposition of plant litter is an important process needed for investigation when a detailed study for a forest community is initiated. Litter decomposition encompasses breakdown of organic matter into CO_2 and nutrients via physical, biological and chemical pathways (Aerts 1997). Climatic factors, such as temperatures, rainfall and seasonal variations influence the existence of microbes and other soil fauna that significantly affect the rate of decomposition (Krishna and Mohan 2017). The present study was aimed to assess decomposition patterns of different litter components of muli bamboo in relation to monthly average precipitation (MAP) and monthly average temperature (MAT) (Fig. 1).

MATERIAL AND METHODS

Study site

The study was carried out in a bamboo forest dominated by *Melocanna baccifera* Roxb. (muli) in Tanhril village near Mizoram University Campus, in Northeast India. The area have an altitude of 800 m a.s.l. and located between 23°43’44" N latitude and 92°43’48" E longitude, received an annual rainfall of 250 to 300 cm and average air temperature of 17.4 to 24.5°C. The soil was yellowish-red in color, pH of 5.5 to 6.6 and the area falls under sub-tropical climatic condition.

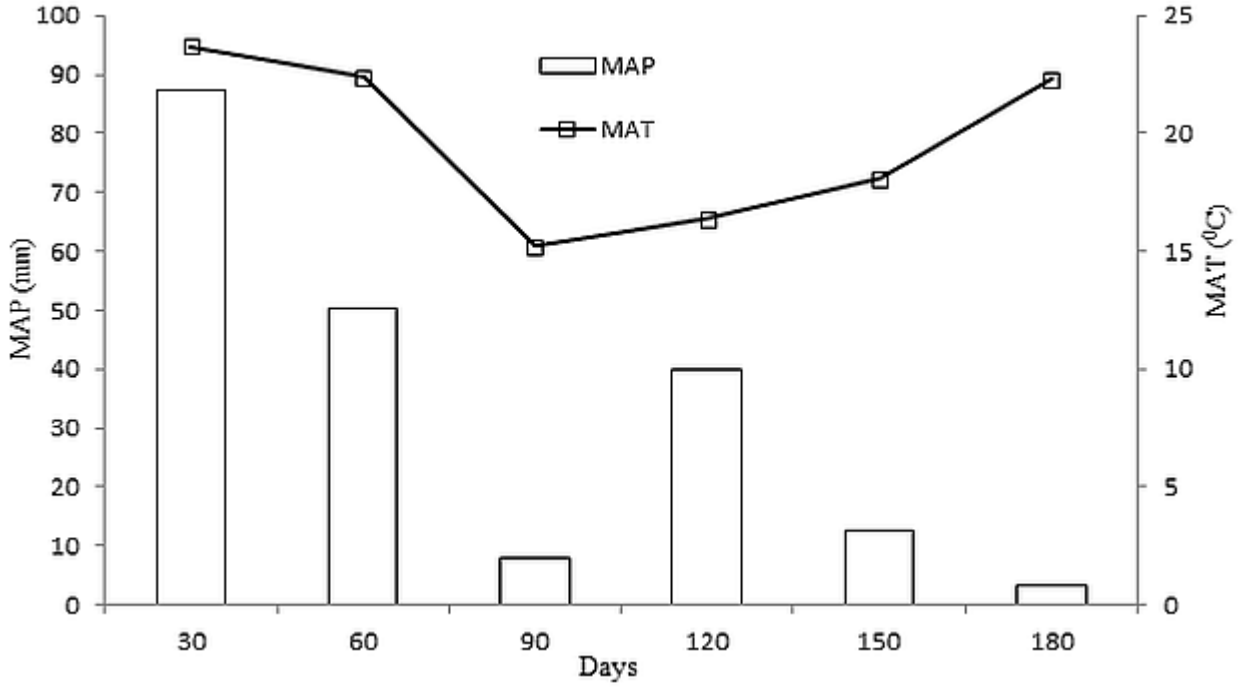

Figure1. Monthly average precipitation (MAP) and Monthly average temperature (MAT) in the different months

Decomposition of litter

Different components of freshly fallen litter of muli were collected from the forest floor in the month of August, 2019. The litter was differentiated into leaf, branch, sheath and culm components and air dried till constant weight. The branch and culm components were cut into small sections. 10g each of the different components of litter were put in plastic mesh bags having sizes of 20 x 20 cm and mesh size of 2 x 2 mm. Thirty six numbers of litterbags for each type of litter components were prepared and placed on the forest floor after removing the litter layer in the month of September, 2019. Three litterbags for each of the litter were picked up every 30 days. The study was continued only for 180 days due to lockdown imposed by the Covid-19 pandemic. The remaining mass in the bags were carefully removed and washed with tap water in order to remove adhering soil. Weight of remaining mass was determined after air drying till constant weight. Decomposition constant (k) was determined following the exponential model of Olson (1963).

$$\text{Ln}\ (X_1/X_0) = -kt$$

Where, X_0 is the original mass of litter, X_1 is the amount of litter remaining after time t, k is the decomposition constant and t is the time interval. The time required for 50% mass loss was calculated as t_{50}= 0.693/k.

Statistical analysis

One way ANOVA followed by Tukey's post hoc test was employed to examine any statistical differences in mass loss and k values across different sampling period and between the different components of litter. Pearson's coefficient of correlation was evaluated for k with MAP and MAT. All the statistical analyses were done using MS Excel and SPSS.

RESULTS

The loss of biomass was much higher in leaf litter with remaining mass of 1.07±0.5 g ($p<0.001$) followed by sheath litter with 4.27±1.20 g (Fig. 2). Minimum loss of biomass was recorded in the culm litter with remaining mass of 7.83±1.2 g. The branch litter also recorded high remaining mass with 7.20±1.2 g. The % remaining mass at 180 days was 11% leaf, 62% sheath, 72% branch and 78% culm litter. The loss of mass was rapid in the beginning months in leaf, branch and culm litter however, in sheath litter the loss of mass was lower in the initial months which gradually increased in the following months ($p<0.002$).

The decomposition constant k (month^{-1})was

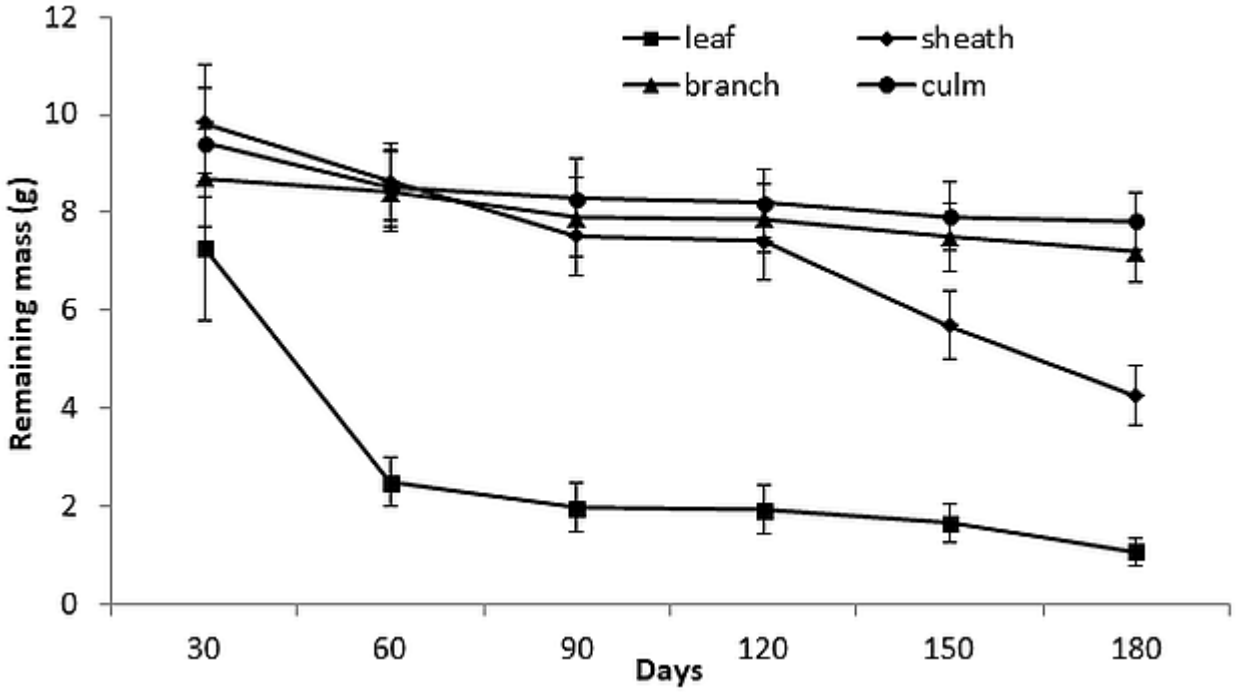

Figure 2. Remaining mass of different types of litter

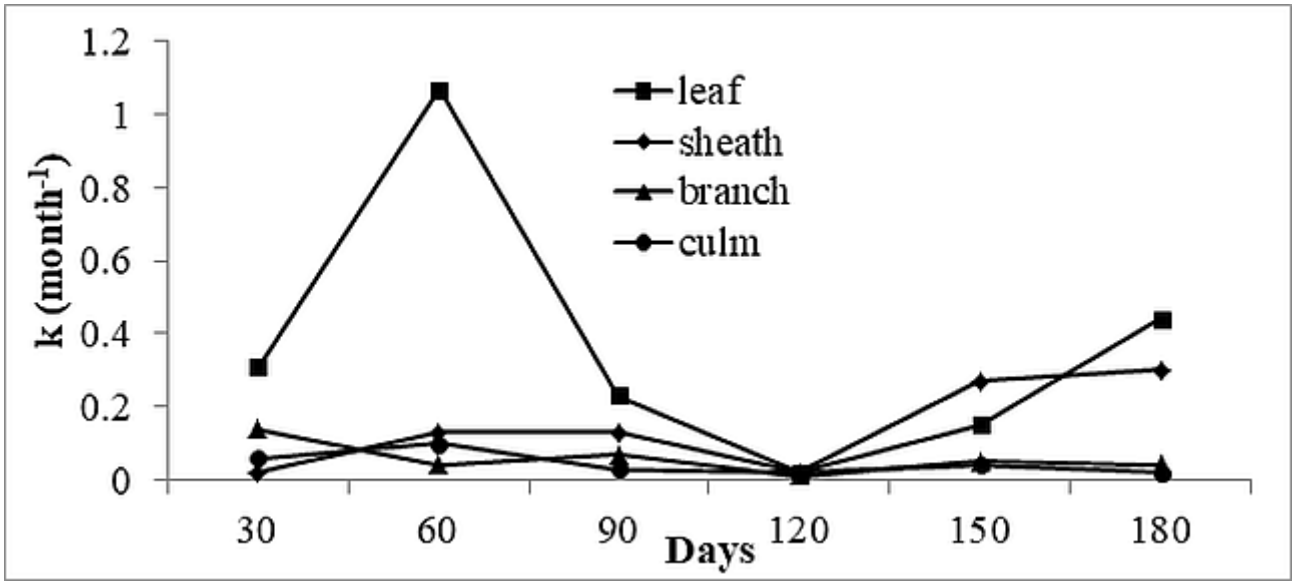

Figure 3. Decomposition constant k (month^{-1}) for the different types of litter

maximum at 60 days with 1.07 in leaf litter and minimum at 120 days with 0.02 and 0.10 in leaf and culm litter respectively ($p<0.03$). In sheath litter maximum k was recorded at 180 days and minimum at 30 days. The branch litter recorded a maximum of 0.14 at 30days and minimum of 0.01 at 120 days (Fig. 3). Significant variation observed for k in the different months among the different litter.

Significant positive correlation of k (month^{-1}) was recorded with MAT in leaf litter ($r=0.60$; $P<0.05$) (Table 1). The branch litter showed significant correlation only with MAP($r=0.58$; $p<0.05$); culm litter with MAP ($r=0.57$) and MAT ($r=0.55$) at $p<0.05$. However in sheath component k was inversely correlated with MAP ($r= -0.76$; $P<0.05$).

Maximum k (yr^{-1}) was recorded in leaf litter with

Table 1. Pearson's coefficient of correlation of k (month^{-1}) with MAP and MAT (n=6)

		r
Leaf	MAP	0.20^{insg}
	MAT	0.60*
Sheath	MAP	-0.76*
	MAT	0.06^{insg}
Branch	MAP	0.58*
	MAT	0.44^{insg}
Culm	MAP	0.57*
	MAT	0.55*

Significant at*: P<0.05; insg. :insignificant

Table 2. k (year^{-1}) and t_{50} for the different types of litter

	k (year^{-1})	t_{50} (days)
Leaf	4.46	57
Sheath	1.70	146
Branch	0.65	387
Culm	0.50	504

4.46 (Table 2) and took 57 days for 50% decomposition of the whole mass providing more evidence for rapid rate of decomposition. In sheath litter k (yr^{-1}) was 1.70 and t_{50} of 146 days. The branch and culm litter have very low k (yr^{-1}) with 0.65 and 0.50 respectively. Therefore the time for 50% rate of decomposition was also high with 387 and 504 days.

DISCUSSION

The negative response of sheath litter to MAP can be attributed to resistance to rapid decomposition in the initial stage which corresponds to the rainy months. However, a gradual increase in decomposition was observed in the latter stages after the breakdown of the hardened cellulose by the impact of precipitation. Leaching due to rainfall increase palatability of litter by washing out tannins and lignin, which tended to increase the diversity of decomposers, thereby increasing litter mass loss rate (Dilly et al. 2001). The leaf litter showed maximum rate of decomposition and corresponds to temperature gradient. Both the branch and culm litter showed a slow rate of decomposition due to presence of more lignin however, they respond to positively to MAP. Zhang et al. (2008) showed that mean annual temperature and mean annual precipitation accounted for 72-87% on variation of k owing to stimulated activities of the decomposer community such as fungi and soil fauna. Deka and Mishra (1982) also reported accelerated rate of decomposition in leaf litter of *Dendrocalamus hamiltonii* bamboo during warm and moist season. Similar reports on positive correlation of decomposition constant k of leaf litter with mean annual precipitation and mean annual temperature were shown by Lee et al. (2015) from an evergreen broadleaved trees in Jeju islands in Southern Korea and Tripathi et al. (2006) from a dwarf bamboo forest in Northern Japan. Devi and Yadava (2007) reported a positive correlation of wood litter with rainfall in a dipterocarpus forest in Northeast India.

The k (yr^{-1}) of leaf litter in the present species was very high compared to *Bambusa cacharensis* (1.44), *Bambusa vulgaris* (1.71) and *Bambusa balcooa* (1.64) reported from Barak valley Northeast India (Nath and Das 2011). However the k (yr^{-1}) of sheath litter in the present study was comparable with their studies with 1.31, 1.21 and 1.07 in the three bamboo species, respectively. The present report on sheath litter was also comparable with moso bamboo forest from China with k (yr^{-1}) of 1.46 and 172 days for 50% rate of decomposition Zheng et al. (2021). The k (yr^{-1}) of 0.21 leaf litter and t_{50} of1241 days and k (yr^{-1}) of 0.22 and t_{50} of 1168 days of culm litter of the dwarf bamboo *Sasa kurilensis* reported by Tripathi et al. (2006) was low compared with the present study. Aerts (1997) compared k for leaf litter in three climatic regions and reported 0.36 for temperate region, 0.35 for Mediterranean region and 2.33 for tropical region forests. Alvarez et al. (1992) reported that k values for leaf litter is often greater than 1.0 for tropical forests indicating that leaf litter turnover occurred in a year or less than a year. The k for leaf litter of muli bamboo in the present study was very high although the sheath, culm and branch litter recorded a lower k value.

From the results obtained it can be conclude that leaf litter decomposition takes place at a rapid rate in muli bamboo forest indicating a faster rate of deposition of nutrients in the soil. More organic

matter and nutrients are added to the soil during warm and wet season.

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Authors' Contributions: All authors contributed equally

Conflict of Interest: Authors declare no conflict of interest

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