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Soil Microbial Biomass and its relation with Environmental variables in Guvvalacheruvu dry deciduous forest of Palakondalu hills, Southern Eastern Ghats, Andhra Pradesh, India

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ABSTRACT

Soil Microbial Biomass represents the active fraction of the Soil Organic Carbon. The turn over rate of SMB is rapid, hence it plays a key role in the cycling of essential nutrients in the forest ecosystem. SMB was found to be influenced by environmental factors like soil moisture, soil temperature and forest features like soil organic carbon, litter quality. SMB was measured in each of the month by Chloroform fumigation method along with SOC, SM and ST variables by standard methods. Multiple regression models was used to know the relation between SMB and independent factors like SOC, SM and ST. Soil Moisture was found to be the key variable that influence the SMB content and a non significant positive was observed between SMB and SOC.

Key words: *Chloroform fumigation, Dry deciduous forest, Regression, Soil Microbial Biomass.*

Introduction

Soil microbial biomass (SMB) represents the active and labile portion of soil organic matter (Bargali *et al*., 2018). It plays an important role in the decomposition of organic matter by which the supply of essential nutrients is possible in the forest ecosystems (Singh *et al*., 1989). Soil microbial biomass carbon accounts for only 1-3% of the total soil organic carbon, but due to its fast turnover rate and rapid release of nutrients, its role in nutrient cycle is greater than its size (Schnurer *et al*., 1985). In both natural and disturbed forest ecosystems SMB acts as a reservoir of 'C' and mineral nutrients from which the essential nutrients are liberated after the completion of microbial biomass cycle (Singh and Gupta, 2018). This ecological role of nutrient cycling by microbes depends on the environmental conditions like soil moisture, temperature and the type of soil organic matter Bargali *et al*. (2018). Hence the prevailing forest vegetation differing in the quality and quantity of litter, root exudates, soil properties may influence the soil microbial biomass content Bargali *et al*. (2015). The variation in the microbial biomass content in relation to forest vegetation can be linked to plant diversity, percent of easily decomposable organic compounds, root density in the rhizosphere, microclimate and soil structure Moore *et al*. (2000).

Pterocarpus santalinus, Anogeissus latifolia and *Chloroxylon swietenia* are the dominant tree species in the dry deciduous forests of southern Eastern Ghats of Andhra Pradesh. These forests occur on nutrient poor soils with distinct seasonality and harsh dry conditions (Ramana and Reddy, 2020). It is observed that, seasonal fluctuations in temperature, rainfall and accumulation of organic matter from fallen plant litter also influence the soil microbial biomass carbon in the forest ecosystems (Lepcha and Devi, 2020). In addition anthropogenic disturbances in the dry forests result in changes in the microbial community and its activities (Srivastava and Singh, 1989). Majorly, the information on soil microbial biomass carbon is available from humid and temperate forests that occur in Himalayas and North East region Arunachalam and Arunachalam (2000), Bargali *et al*. (2018), Devi and Yadava (2006); Lepcha and Devi (2020). But apart from the studies in Vindhyan forests Srivastava and Singh (1989), the information on seasonal variation of soil microbial biomass carbon in dry deciduous forest of southern Eastern Ghats is limited. In the present study, the primary objective is to know the variables that influence the seasonal variation of soil microbial biomass in the dry deciduous forest of Guvvalacheruvu region of Palakonda hill ranges.

Study Area and Materials and Methods

The study was carried out in Guvvalcheruvu forest comprising of both dry deciduous forests 14°16′ 28.3" N 78° 51′57.6" E and dry thorn forests 14° 19′22.4" N 78° 46′14.7" E in Palakonda hill ranges of southern Eastern Ghats. Soil samples were collected randomly at 0-15 cm depth in three replicates from the twelve 10X 10m quadrats laid in the Guvvalacheruvu forest in each of the month in 2021-22 year.

Soil samples were thoroughly mixed to form a composite sample and the collected soil samples were air dried and passed through 2 mm sieve for soil samples analyses. Physico-chemical soil parameters such as soil pH, electrical conductivity (1:5 soil:water samples), soil bulk density (Core method), soil moisture (oven dry method) soil Organic Carbon Walkley and Black (1934) were measured by following standard procedures (Kapur and Govil, 2004). Soil texture was determined by sieving the soil through different sized holes; sand -0.02 -2.0 mm, silt 0.002-0.02 mm and clay<0.002 mm and the proportion of soil particles was estimated by weight Misra (1968). Soil Microbial Biomass (SMB) was measured by Chloroform-Fumigation Extraction procedure, in which, soils are exposed to chloroform vapour for 24 hours to lyse the microbial cells. Then the carbon is extracted from soil by 0.5M K_2SO_4 solution in both Fumigated (CF) and Non-Fumigated samples (CNF) and organic carbon in the extract was estimated by acid-dichromate oxidation procedure and the difference between CF and CNF is noted as SMBC (Vance *et al*. 1987).

SMB (μg/g soil) = $E_{CF} - E_{CNF}/K_{E.C}$. [E_{CF} = Extractable 'C' in the Fumigated Soil; E_{CNF} = Extracted Carbon in Non-Fumigated Soil; $K_{E.C}$. = 0.38].

Results and Discussion

Physico-chemical properties of the dry deciduous forest soil indicated that; the soils belong to sandy loam soil texture type (Sand : 66-58%; Silt 13-32% and Clay 10-21%), the soils are slightly acidic to neutral type (6.1 to 7.5), electrical conductivity is in the range of 91 – 168.6 micro Siemens/Cm), the bulk density is in the range of 1.08 to 1.65 g/Cm^3. The bulk density showed significant negative relationship with SOC (r =0.78; P<0.05) and such similar negative relationship was recorded in the forest soils of southern Eastern Ghats (Ramana and Reddy 2019). The above mentioned soil parameters did not vary significantly in the studied year. The mean ± Standard Error (S.E) values of Soil Microbial biomass was (148.1 ± 16.1μg/g), Soil organic carbon (0.86±0.06 %), soil moisture (4.51±0.57%) and soil temperature (34.78±1.69 ^{0}C) in each of the month of a year are provided in Table 1. The Coefficient of Variation values suggest that soil moisture (43.8%) was more variable followed by SMB (37.8%) and SOC (24.6%) across the months. A maximum value of SMB was recorded in the month of June (233.1 μg/g) and the minimum was in March (48μg/g). The SMB trend revealed that higher values were registered at the break of the summer season and initiation of first rains and then maintained gentle decreasing tendency in the rainy months and further steadily got decreased in cool winter months and rapid reduction was registered in the beginning of summer month and a gentle upward trend was followed later (Fig.1). Such seasonal observations of higher values of SMB in rainy season were recorded in Central Himalayan forest soils Bargali *et al*. (2018), Tarai Sal Forests of Nepal Bhattarai and Mandal (2020) and Eastern Himalayan Humid forests Lepcha and Devi (2020). This may be due to the process of immobilisation of nutrients by the microbes from the decomposing litter is at a higher rate due to

Table 1. Monthly values of Soil Microbial Biomass (SMB), Soil Organic Carbon (SOC), Soil Moisture (SM) and Soil Temperature (ST) in the Guvvalacheruvu forest of southern Eastern Ghats

Month	SMB (µg/g)	SOC (%)	SM (%)	ST (⁰C)
June	233.1	0.99	10.51	32.6
July	212.6	0.848	10.8	29.2
Aug	190.5	0.639	9.6	31.6
Sep	181.1	0.86	8.9	34.2
Oct	174.2	0.87	10.5	32.4
Nov	159.1	0.79	8.7	27.6
Dec	151.15	0.85	6.8	30.6
Jan	135.9	1.021	5.68	30.7
Feb	108.4	0.92	5.42	38.7
March	48	0.529	1.98	40.2
April	71.15	1.17	2.77	43.9
May	112	0.78	2.44	44.5
Mean ± S.E.	148.1±16.1	0.86±0.06	4.51±0.57	34.78±1.69

rapid microbial activities during this wet season Usman *et al*. (2000); Devi and Yadava (2006). Further the growth of fungi also increased during this season due to high relative humidity and thus contributing to high SMB Acea and Carballas (1990). But contrast results with high SMB content in dry summer season were also recorded in dry tropical deciduous forests of Vindhyan hill ranges Singh *et al.* (1989) and sub tropical forests of North East India Arunachalam and Arunachalam (2000) and this condition can be understood by the variation in plant species composition, location, elevation and prevailing rainfall pattern Lepcha and Devi (2020).

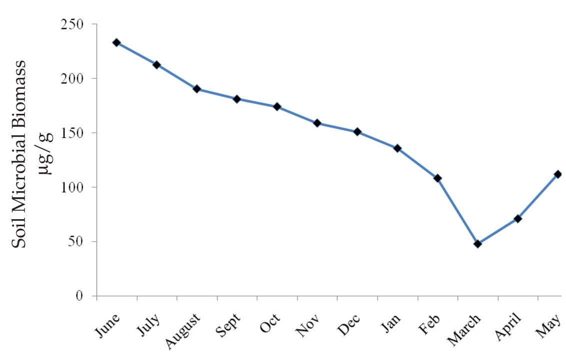

Fig. 1. Soil Microbial Biomass trend in each of the month in a year

Multiple regression analysis results revealed that the interaction among the three independent variables - SOC, SM and ST have explained the dependent variable SMB variation up to 72.6% ($r^2 = 0.726$; ($F_{(3,11)}$=8.90 $P<0.05$) with a regression equation; SMB = 137.93 + 73.35 (SOC) + 14.92 (SM) – 3.49 (ST). But when they are considered independently, only SM was could explain the SMB variation close to significance level (P = 0.054; Beta value = 0.531) and the other two variables could not explain the variance independently. Thus among these variables, SM has prominently determined the SMB variation followed by ST (Beta value =-0.365) which showed negative non significant relationship and SOC has shown positive non significant relationship; Beta value =0.29).

The positive relationship between SMB and SOC in these nutrient poor soils indicate that increment of SOC can promote more microbial activity leading to more nutrient availability in these forests. Further, at appropriate soil moisture levels and moderate temperature owing to rapid decomposition of plant litter, soil microbial biomass was higher in wet season followed by cool winter months and low in harsh dry summer season. Thus, harsh dry conditions in summer season leading to low microbial activity and even death of the microbes may influence the release of essential nutrients through mineralisation at the beginning of the rainy season which will help the plant growth in these dry deciduous forests that occur on nutrient poor soils.

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