International Journal of Ecology and Environmental Sciences 44 (1): 103-105, 2018
ISSN: 2320-5199 (Online)

Short Communication

Dynamics of Soil Respiration in a Tropical Semi-evergreen Forest on Two Different Slope Gradients

ANGOM SARJUBALA DEVI[1] AND SABRINA LALHMANGAIHZUALI[2]

[1,2]*:Department of Environmental Science, Mizoram University, Post Bag190, Tanhril, Mizoram, India*
E-mail: [1] angom75@yahoo.com; [2] sabrinachhangte@gmail.com

ABSTRACT

CO_2 is released from soil as a final product of organic matter decomposition by microorganisms. It is therefore important to understand soil carbon dynamics and its controlling factors. Soil physico-chemical characteristics and climatic condition plays an important role in maintaining the CO_2 flux from soil. In addition to these factors, lesser known factor like slope gradient maybe important in mountainous terrain. Therefore the present study exmines the impact of slope gradient on soil respiration. The average soil respiration was 2.28gC m^{-2} d^{-1} in the moderately gradient site and 1.74gC m^{-2} d^{-1} in the steep gradient site. Soil moisture, soil temperature and total organic C were also higher in the moderately gradient site. Significant positive correlation was observed between total organic C and soil respiration in both the sites.

Key Words: Mountainous Terrain, Soil Organic C, Effect of Slope.

INTRODUCTION

Carbon dioxide emission due to soil respiration is a major component of greenhouse gas emission. A small change can have great effect on the concentration of atmospheric CO_2 (Wangluk et al. 2013). Soil respiration is sensitive to type of vegetation, substrate supply, soil temperature, soil moisture, soil oxygen, litter quality, bulk density, soil texture and soil pH (Luo and Zhou 2006).In tropical regions, variations in both soil temperature and moisture are recognized as the main factors (Adachi et al. 2009). Many studies have found linear correlation of soil respiration with temperature and precipitation (Schimel et al. 2002, Schuur 2003). However studies on influence of slope gradient which is a least known factor but highly important in mountainous locations are rarely done.Therefore the present study was undertaken to study the role of slope gradient on soil respiration in a tropical semi-evergreen forest.

MATERIALS AND METHODS

A tropical semi evergreen forest located within Mizoram University campus, Tanhril which is 19 km westward fromAizawl – the capital of Mizoram, Northeast India having an altitude of 1062 to 1188m asl was selected as the study area. The area has latitude of 23.42ºN to 23.45ºN and longitude of 92.42º to 92.44º E and receives annual rainfall of 275cm with an average temperature of18.6 ºC to 30.2 ºC.Two sites were selected in the study area based upon the slope gradient. The first site had a slope gradient of 20-23% which was designated as moderately gradient site (MO) and the second site had a slope gradient of 25-30% which was designated as steep gradient site (ST).

Soil analysis

Three soil samples each from the two sites were collected from 0-10cm monthly for six months starting from October, 2013 till May, 2014. Analysis of soil could not be done for the months December, 13 and January, 14. The fresh soil samples were divided into two parts. The first moist part was used for estimation of pH, moisture and CO_2 evolution. The second part was air dried and analysis for total organic C was done. For every analysis three replicates of the soil were taken and

analyzed. Bulk density was determined once by using soil corer method and soil temperature was recorded monthly by using soil thermometer.

Soil moisture was determined by using gravimetric method, soil pH by using digital pH-meter, organic C by Walkley and Black's titration method and CO_2 evolution by using alkali absorption method.

The data obtained were subjected to analysis of variance, correlation and regression analysis by using Microsoft Excel 2010.

RESULTS

The pH of soil varied from 4.4 to 5.8 in MO and 4.3 to 5.9 in the ST which indicates the soil of the forest under present study was acidic. Bulk density varied from 0.11 to 0.187g cm^{-3} in MO and from 0.150 to 0.200g cm^{-3} in ST. Although there was no significant difference between the two sites the results indicates that bulk density was more in ST. Soil moisture varied from 22.5 to 53.4% in MO and from 20.7 to 43.7% in ST (Figure 1). The average soil moisture was higher in MO (35.61%) than in ST (31.20%). Soil temperature was also found to be higher in MO (21.00 ºC) than ST (20ºC) (Figure 1).

Maximum total organic C was found during October,2013 in both the sites, MO: 4.32% ;ST: 3.58% and least during May, 2014 in both the sites (MO: 2.20%; ST: 1.45%). Total organic C was comparatively higher in MO than ST (Figure 2). The rate of soil respiration was found to correspond accordingly with total organic C in both the sites. Maximum soil respiration was recorded during October, 2013: MO:4.62gC m^{-2} d^{-1}; ST: 3.45gC m^{-2} d^{-1} and minimum during May, 2014: MO: 0.94gC m^{-2} d^{-1}; ST: 0.66g C m^{-2} d^{-1}. The average soil respiration was higher in MO (2.28gC m^{-2} d^{-1}) than ST (1.74g C m^{-2} d^{-1}). After taking up regression analysis it was observed that there was significant positive correlation existed between soil respiration and total soil organic C in both the sites (MO: r^2=0.88; ST: r^2=0.59) (Figures 3 and 4).

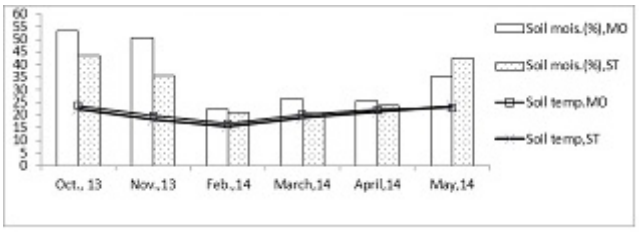

Figure 1. Monthly variation of soil moisture and soil temperature in the two sites.

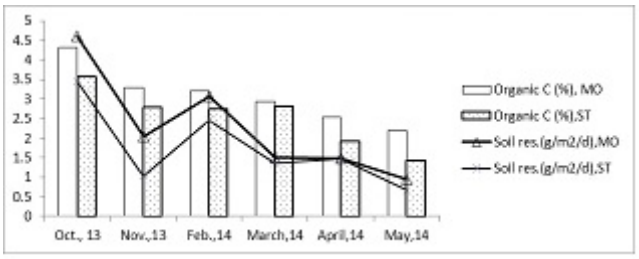

Figure 2. Monthly variation of soil organic C and soil respiration in the two sites.

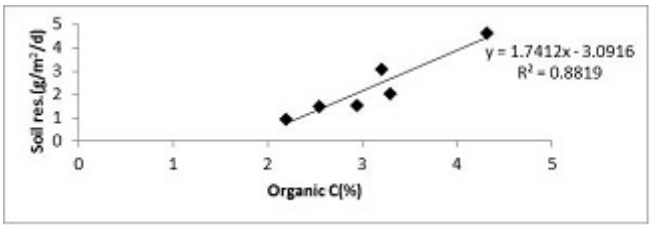

Figure 3. Relationship between soil respiration and organic C in moderate site

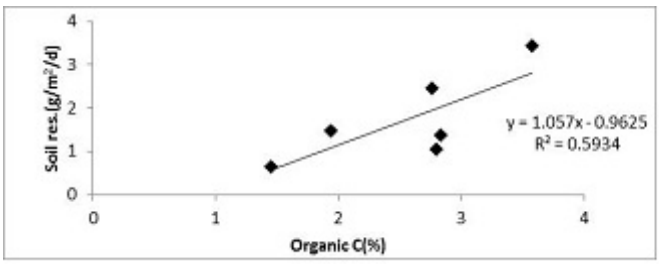

Figure 4. Relationship between soil respiration and organic C in steep site.

DISCUSSION

It was observed that soil moisture, soil temperature, total organic C and soil respiration were more in the moderate site than the steep site. Since soil moisture was higher in the moderate site bulk density was lower in the moderate site compared to steep site. Although there was no significant correlation between soil respiration with other soil physico-chemical properties a significant positive correlation with total organic C in the present study site is an important aspect. It indicates that more deposition of organic carbon was there in the moderate site which can lead to more rate of soil respiration. The

lower slope gradient may have led to more deposition of the organic matter in the moderate site. Lee and Jose (2003) have also reported significant positive correlation between soil organic matter with soil respiration (r=0.74) in Cottonwood and Loblolly pine forest in Santa Rosa County, Florida. The soil respiration in their study site ranged from 1.77 to 2.35gC /m^2/d which is much lower than the present study site. Schulze (1967) stated that the tropical wet and constant warm habitats have soil respiration rates which are five times as large as mean European rates illustrating the limitation of soil respiration through climatic conditions and primary production in the vegetation.

Annual rate of soil respiration in the moderate site was 830.0gC/m^2/yr and 635.0gC/m^2/yr in the steep site. The present rate was higher than Rout and Gupta, (1989) which have reported 520 to 664gC/m^2/yr from Oak and Pine forest in Northern India. Wangluk et al. (2013) have reported a range of 326.8 to 313.2 gC/m^2/yr from a tropical Teak and Mixed deciduous forest respectively in Lapang province, Thailand, which was much lower than the present forest. However the elevation was 300 to 350 m asl which was much lower than the present study site. The rate of soil respiration was comparatively high indicating high level of stability in the present forest site.

It is concluded that in mountainous landscapes the role of slope gradient with reference to amount of organic matter accumulated is an important factor in determining the rate of soil respiration in forest ecosystems.

REFERENCES

Adachi, M., Ishida, A., Bunyavajchewin, S., Okuda, T. and Koijumi, H. 2009. Spatial and temporal variation in soil respiration in a seasonally dry tropical forest, Thailand. Journal of Tropical Ecology 25: 531-539.

Lee, H.K. and Jose, S. 2003. Soil respiration, fine roots production and microbial biomass in cottonwood and loblolly pine plantations along a nitrogen fertility gradient. Forest Ecology and Management 185: 263-273.

Lou, Y and Zhou, X. 2006. Soil Respiration and Environment. Academic Press, London. 328 pages,

Rout, S.K. and Gupta, S.R. 1989. Soil respiration in relation to abiotic factors, forest floor litter, root biomass and litter quality in forest ecosystems of Siwaliks in northern India. Acta Oecologia 10: 229-244.

Schimel, D.S.; House, J.I.; Hibbard, K.A. and Wirth, C. 2001. Recent patterns and mechanisms of carbon exchange by terrestrial ecosystems. Nature 414: 169-172.

Schulze, E.D. 1967. Soil respiration of tropical vegetation types. Ecology 4: 652-653.

Schuur, E.A.G. 2003. Productivity and global change revisited: the sensitivity of tropical forest growth to precipitation. Ecology 84: 1165-1170.

Wangluk, S.; Boonywat, S.; Diloksumpun, S. and Tongdeenok, P. 2013. Role of soil temperature and moisture on soil respiration in a teak plantation and mixed deciduous forest in Thailand. Journal of Tropical Forest Science 25: 339-349.

Received 29 September 2017
Accepted 18 December 2017