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Contribution of root systems on soil CO_2 efflux in a tropical rainforest in Borneo, Malaysia

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ABSTRACT

Recently published data suggests that contribution of root systems is significantly important for the variation of soil CO_2 efflux in an Asian forest. In this study, we aimed to examine the contribution of root systems on soil CO_2 efflux in a tropical rainforest in Borneo, Malaysia, by 1) measuring fine root respiration using a root respiration chamber and 2) investigating variation of soil respiration according to the changes of distance from emergent trees, *Dryobalanops aromatica*. Our results indicate that fine root respiration varied from 0.3 to 6.5 nmol g^{-1} s^{-1}, 2.4 nmol g^{-1} s^{-1} in average. We also found that soil CO_2 efflux 0.5 m apart from the emergent trees was significantly higher than those of 5 m and 10 m distances, suggesting that root systems could have a large impact on the fluctuation of soil CO_2 efflux in an Asian tropical rainforest.

KEYWORDS: rhyzosphere, root respiration, soil respiration, spatial variation, temporal variation, tropical forest.

1. INTRODUCTION

It is known that soil carbon dioxide (CO_2) efflux from tropical forests play an important role in global C balance. However, our knowledge about the fluctuations and mechanisms of soil CO_2 efflux in Asian tropics is still poor. Since the main sources of CO_2 are considered to be roots and soil microorganisms, understanding of the contribution of each source on the CO_2 efflux is crucial. Recently published data suggests that contribution of root systems is significantly important for the variation of soil CO_2 efflux in an Asian forest (Katayama et al., 2009). Our study conducted in a tropical rainforest in Malaysia showed that emergent trees and their roots could be primary factors controlling spatial variations in soil CO_2 efflux. In this study, we aimed to examine the contribution of root systems on soil CO_2 efflux in a tropical rainforest in Borneo, Malaysia, by 1) measuring fine root respiration using a root respiration chamber and 2) investigating variation of soil respiration according to the changes of distance from emergent trees, *Dryobalanops aromatica*.

2. MATERIAL AND METHODS

The study was carried out in a natural tropical rainforest in Lambir Hills National Park (4°12'N, 114°02'E), Sarawak, Malaysia. The mean annual rainfall in this area was ~2740 mm and the mean annual temperature was ~27 °C, with little seasonal variation (Kumagai *et al*., 2005). It was a mixed dipterocarp forest, containing various dipterocarp species covering 85% of the total park area. In this forest, four experimental plots, 10 m in diameter, were established around emergent trees, *Dryobalanops aromatica* (DA) and two plots around *Shorea beccariana* (SB).

In December 2008 and February 2009, fine roots in 15 cm soil depth were collected at 5 sampling points in three DA plots and their respiration was measured using a small respiration chamber connected to an infra-red gas analyzer (EGM-4, PP systems) immediately after the sampling. Dry mass of the sampled roots were measured, thereafter. Measurements were repeated 4 times during the experiments.

In February and April 2008, soil respiration (SRC–1, PP Systems) was measured in two DA and SB plots at three different distances (0.5 m, 5 m and 10 m) from the emergent trees. The sampling points were radicalized from the emergent tree in 2-4 different directions in each plot. Soil temperature (CT-150, Takamorikoki) and soil moisture (ThetaProbe type ML2x, Delta–T Devices) content were also measured simultaneously. Measurements were repeated three times at same sampling points in one of the two DA and SB plots. We used analysis of variance for identifying the differences of soil respiration between distances (0.5 m, 5 m and 10 m) from the emergent trees.

3. RESULTS AND DISCUSSION

The results indicate that fine root respiration varied from 0.3 to 6.5 nmol $g^{-1} s^{-1}$, 2.4 nmol $g^{-1} s^{-1}$ in average. If we assume fine root biomass are 780 g m^{-2} and soil CO_2 efflux is 5 µmol m^{-2} s^{-1}, contribution of fine root respiration in this forest is estimated to be 1.9 µmol m^{-2} s^{-1}, which is 38 % of total CO_2 efflux.

In our study, we also found that soil CO_2 efflux 0.5 m apart from the emergent trees was significantly higher than those of 5 m and 10 m distances ($P < 0.05$) (Figure 1). These results suggest that root systems could have a large impact on the fluctuation of soil CO_2 efflux in an Asian tropical rainforest.

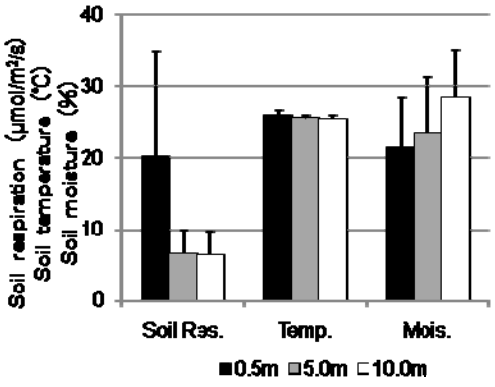

Figure 1. Comparison of soil respiration, temperature and soil moisture among different distance from emergent trees.

REFERENCES

Katayama, A, Kume, T., Komatsu, H., Ohashi, M., Nakagawa, M., Yamashita, M, Otsuki, K., Suzuki, M. & Kumagai, T. 2009. Effect of forest structure on the spatial variation in soil respiration in a Bornean tropical rainforest. Agricultural and Forest Meteorology in press.

Kumagai, T., Saitoh, T.M., Sato, Y., Takahashi, H., Manfroi, O.J., Morooka, T., Kuraji, K., Suzuki, M., Yasunari, T. & Komatsu, H. 2005. Annual water balance and seasonality of evapotranspiration in a Bornean tropical rainforest. Agricultural and Forest Meteorology 128, 81–92.