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Partitioning root respiration into the growth and maintenance components of fine roots in a young larch forest

環境資源学専攻　地域環境学講座　生態環境物理学　崔　鋭

1. Introduction

It is reported that forests contain soil carbon (C) of 618 Pg in the world (Brown, 1996), which accounts for roughly 41% of global soil C. Soil respiration (R_s) is the second largest flux in the global C cycle (Raich and Schlesinger, 1992). Therefore, understanding variation in soil CO_2 efflux is critical to accurately predict the global C cycle. In addition, fine root dynamics would be highly involved in CO_2 efflux because of its essential function in root respiration. In this study, fine root dynamics (biomass (B) and production (P)) and soil CO_2 efflux were simultaneously measured in a young larch forest in southern Hokkaido over a 12-month period to partition root respiration (R_r) into the maintenance (R_m) and growth (R_g) respirations of woody fine roots.

2. Methods

The study was conducted in Tomakomai, Hokkaido. A forest was naturally established on the bare ground, at which top organic soil was removed after a typhoon attack in 2004. The forest was studded with Japanese larch (*Larix kaempferi*) trees. **E**ight pairs of control and trenched collars were set around larch trees; five and three pairs were installed at 0.5 m (near) and 1 m (far) from the nearest larch stem, respectively. Trenching was made in July 2017. CO_2 efflux was measured on each collar (0.25 m^2) using a chamber system bimonthly in the snow-free period from May 2017. Soil temperature (T_s) and soil water content (SWC) were continuously measured. B and P of the fine roots of larch trees were measured by the sequential core sampling and ingrowth core methods, respectively, in every control collar at intervals of about 60 days in the snow-free period from July 2017. R_r was estimated as the difference between soil CO_2 effluxes in control and trenched collars considering root decomposition (R_d) in trenched collars, and then R_r was partitioned into R_m and R_g using the following model.

$$R_r = R_g + R_m + h = c \cdot P + d \cdot exp(f \cdot T_s) \cdot B + h, \qquad (1)$$

where c, d, f and h are parameters determined by curve fitting.

3. Results and Discussion

Soil CO_2 efflux showed a significant exponential relationship with T_s but was not correlated to SWC. Using the exponential relationship, annual soil CO_2 efflux was calculated from continuous T_s data. The annual values (n = 5 or 3) from September 2017 were 400 ± 170 (R_s), 284 ± 98 (R_T in trenched collars) and 7.3 ± 1.4 (R_d) g C m^{-2} yr^{-1} in near collars, and 303 ± 81 (R_s), 229 ± 35 (R_T) and 3.4 ± 0.6 (R_d) g C m^{-2} yr^{-1} in far collars. As a result, annual R_r was 123 ± 105 and 77 ± 50 g C m^{-2} yr^{-1}, respectively, in near and far collars. For the same period, mean B was 63 g C m^{-2} and annual P was 80 g C m^{-2} yr^{-1}. Using the data of soil CO_2 efflux and fine root dynamics, Eq. (1) was parameterized (P = 0.05), and then annual R_g and R_m were estimated to be 48 and 31 g C m^{-2} yr^{-1}, respectively. The result suggests that root respiration of the fine roots of young larch trees (R_g + R_m) accounted for 66% of total R_r, including the respiration of thicker roots.

4. Conclusions

A relatively simple model was parameterized using field data of soil CO_2 efflux and fine root dynamics. Using the model, total root respiration was partitioned into the growth and maintenance respirations of the fine roots of young larch trees.