International Symposium “Root Research and Applications”
RootRAP, 2–4 September 2009, Boku – Vienna, Austria

Seasonal changes in fine root respiration and morphological traits in a broad-leaved forest in Japan

Naoki Makita[1], Yasuhiro Hirano[2] ,Yuji Kominami [2], Masako Dannoura[3] and Yoichi Kanazawa[1]

[1] Graduate School of Agricultural Science, Kobe University, Kobe 657-8501, Japan
[2] Forestry and Forest Products Research Institute, Kyoto 612-0855, Japan
[3] Graduate School of Agriculture, Kyoto University, Kyoto 606-8502, Japan
Contact: Naoki Makita E-Mail: makita_701@yahoo.co.jp

ABSTRACT

We examined the seasonal acclimation of fine root respiration to temperature associated with the morphological traits in *Quercus serrata* and *Ilex pendunculos*a trees. The root respiration rates in both species increased with increasing temperature and those of the roots < 0.5 mm in diameter were higher and more variable than the roots > 0.5 mm. In addition, with increasing temperature, the variation in the respiration of the smaller roots widely increased. We conclude that seasonal acclimation of fine root respiration to temperature should be considered not only the diameter but also root life span.

KEYWORDS: root CO_2 efflux, mean root diameter, Q_{10}, temperature.

1. INTRODUCTION

Root respiration is estimated to account for between about 30-50% of total tree respiration and plays a key role in ecosystem level carbon cycling which is a major source of soil CO_2 efflux. In addition, root respiration is critical for important physiological functions such as maintenance, growth, and nutrient uptake. The respiration rates probably change with fluctuations in temperature, because respiration has temperature sensitivity of enzymatically catalyzed reactions (Lambers et al. 2008).

Several studies have reported the temperature acclimation of root respiration in the laboratory and field (e.g. Burton and Pregitzer 2003). However, less is known about the relationships between the temperature acclimation and root morphological traits within 2 mm in root diameter. Recent studies have shown that respiration of very fine roots (< 0.5 mm in diameter) has been estimated to be higher than that of larger roots (Makita et al. 2009). Therefore, our objective of this study was to document the seasonal acclimation to temperature of fine root respiration associated with root diameter in mature trees.

2. METHODS

This study was carried out at Yamashiro Experimental Forest, Kyoto, in a mountainous region of western Japan (34°47 N, 135°50 E). The forest consists of deciduous broad-leaved species (mainly *Quercus serrata*) and evergreen broad-leaved species (mainly *Ilex pedunculosa*). We excavated root segments (< 2 mm in diameter) of *Q. serrata* and *I. pedunculosa* every two month and measured the respiration rates of small fine root segments with a closed static chamber system immediately after sampling a fine root in the field. The relationships in the fine root segment were examined between the respiration rates and morphological traits such as mean root diameter with WinRHIZO Pro 2007a (Regent Instruments, Quebec, Canada). To evaluate the effects of temperature on root respiration, we used an exponential function and calculated the values of Q_{10}, which is an indicator of temperature sensitivity.

3. RESULTS AND DISCUSSIONS

Root respiration rates in both species increased with increasing the temperature (Fig. 1). The Q_{10} values calculated in each root diameter class (0-0.5, 0.5-1.0, and 1.0-1.5 mm) were 2.4, 3.0, and 2.7 for *Q. serrata* and 1.9, 1.9, and 2.1 for *I. pedunculosa*, respectively. The values in both species were within the similar range of about 2.0–3.0 reported in the earlier studies (e.g. Atkin et al. 2000). The Q_{10} values of *Q. serrata* were higher than those of *I. pedunculosa*. We found that differences in Q_{10} between these species may explain the root-respiratory acclimation to seasonal changes in the growth pattern of above- and belowground.

The respiration rates of roots < 0.5 mm in diameter were higher and more variable than those of roots > 0.5 mm (Fig. 1). In addition, with increasing temperature, the variation in respiration of smaller roots widely increased. There is evidence that the respiration differs widely with root life span and root age (Bouma et al. 2001). Therefore, the higher variation in the respiration in this study may result from the roots with different life span. We conclude that seasonal acclimation of the respiration to temperature should be considered not only the root diameter but also root life span and root age.

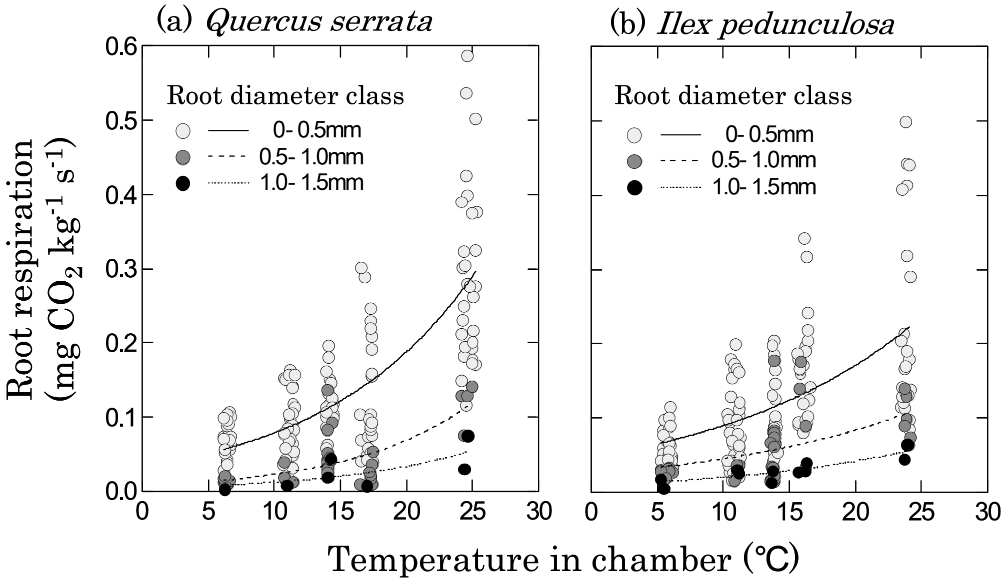

Figure1. The relationship between root respiration and the temperature in chamber in the field.

REFERENCES

Atkin, O.K et al. 2000. Response of root respiration to changes in temperature and its relevance to global warming. New Phytol. 147:141–154.

Bouma, T.J et al. 2001. Estimating age dependent costs and benefits of roots with contrasting life span: comparing apples and oranges. New Phytol. 150:685–695.

Burton, A.J and Pregitzer, K.S. 2003. Field measurements of root respiration indicate little to no seasonal temperature acclimation for sugar maple and red pine. Tree Physiol. 23:273–280.

Lambers, H et al. 2008. Plant Physiological Ecology. 2nd edition. Springer, New York.

Makita, N et al. 2009. Fine root morphological traits determine variation in root respiration of *Quercus serrata*. Tree Physiol. 29:579–585.