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Original Article

Effect of nitrogen fertilizer, root branch order and temperature on respiration and tissue N concentration of fine roots in *Larix gmelinii* and *Fraxinus mandshurica*

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Root respiration is closely related to root morphology, yet it is unclear precisely how to distinguish respiration-related root physiological functions within the branching fine root system. Root respiration and tissue N concentration were examined for different N fertilization treatments, sampling dates, branch orders and temperatures of larch (*Larix gmelinii* L.) and ash (*Fraxinus mandshurica* L.) using the excised roots method. The results showed that N fertilization enhanced both root respiration and tissue N concentration for all five branch orders. The greatest increases in average root respiration for N fertilization treatment were 13.30% in larch and 18.25% in ash at 6 °C. However, N fertilization did not change the seasonal dynamics of root respiration. Both root respiration and root tissue N concentration decreased with increase in root branch order. First-order (finest) roots exhibited the highest respiration rates and tissue N concentrations out of the five root branch orders examined. There was a highly significant linear relationship between fine root N concentration and root respiration rate. Root N concentration explained >60% of the variation in respiration rate at any given combination of root order and temperature. Root respiration showed a classical exponential relationship with temperature, with the Q_{10} for root respiration in roots of different branching orders ranging from 1.62 to 2.20. The variation in root respiration by order illustrates that first-order roots are more metabolically active, suggesting that roots at different branch order positions have different physiological functions. The highly significant relationship between root respiration at different branch orders and root tissue N concentration suggests that root tissue N concentration may be used as a surrogate for root respiration, simplifying future research into the C dynamics of rooting systems.

Keywords: N fertilization, root branch order, root respiration, temperature, tissue N.

Introduction

In global forest ecosystems, root respiration accounts for 10–90% (usually 40–60%) of total soil respiration (Hanson et al. 2000). Root and associated mycorrhizal respiration emits ~18 pg C per year to the atmosphere as CO_2 flux worldwide (Raich and Schlesinger 1992); it consumes 8–50% of the plant photosynthates productivity daily and is a major source of carbohydrate loss in plants (Lambers et al. 2002). Fine root production and mortality (assuming a turnover rate of once per year) account for nearly 30% of the plant's annual net primary production (Jackson et al. 1997). First-order roots (<0.35 mm in diameter) contribute ~50 and 64% to the total C and N flux of the first three root orders combined in longleaf pine (*Pinus palustris* Mill.) (Guo et al. 2008*a*). A better understanding of fine root respiration would help us to understand forest carbon cycles (Burton et al. 2002) and response of vegetation to global environmental change (Atkin et al. 2000).