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Comparison of non-invasive indirect method and trenching to partitioning soil respiration in a hardwood temperate forest

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Although many efforts have been made to develop methods that minimise disturbance to the soil and preserve rhizospheric environment, the partitioning of soil respiration in its heterotrophic and autotrophic components remains a challenge of the ecological studies. Due to the difficulty to measure these two fluxes independently, many modelling studies have considered soil respiration as a unique flux without taking into account that heterotrophic and autotrophic respiration could respond differently to environmental and phonological factors. Understanding the potential controls of soil respiration is crucial to predict the response of terrestrial ecosystems to climate change.

In the present study, carried out in a fifteen-year-old mixed hardwood plantation established on a former agricultural land located in northern Italy, a non-invasive soil respiration partitioning method based on a multiple regression analysis was compared with the invasive method of trenching. In the former approach total soil respiration was expressed as sum of autotrophic and heterotrophic components linearly dependent on a number of selected parameters. Specifically, sampling the soil under the collar of soil respiration measurements we performed a multiple regression analysis, using the fine root (diam. < 2mm) or the total root density as independent variables explaining root respiration variability, the SOC content or the soil N content or the FDA microbial activity as independent variables explaining heterotrophic respiration variability and the total CO2 flux from soil as dependent variable. For trenching approach in June 2005 six trenched plots (50x50x50 cm) were done by digging a 50 cm-deep, 15 cm-large trenches around tree-free areas. Before filling back the trenches with original soil, each plot was isolated with a special polyethylene material that prevents root ingrowths allowing gasses and water exchanges. Soil respiration measurement were taken monthly in trenched and control plots from April 2007 to June 2008 concurrently with soil temperature and soil water content measures by using an EGM4 (PPSystem, UK) gas analyser connected to a soil respiration chamber (SRC). Root contribution to total soil respiration varied between 8.5 to 53% and averaged over all monitored period was 31%.

Generally, root contribution, estimated by indirect method was found to be higher than that estimated by trenching. The microbial activity, measured as fluorescein diacetate hydrolysis, and the fine root density were able to explain the most of the spatial variability of the heterotrophic and autotrophic component of soil respiration over the all experimental period.

The apparent sensitivity of respiration to temperature, expressed as Q10 of exponential function, and estimated under non-limiting soil moisture conditions, were 3.6 and 2.9 for autotrophic and heterotrophic respiration, respectively. A simple linear model best explain the relationship between soil water availability and soil respiration when the soil moisture was at non-optimal levels and the slope of fitted line was used as sensitivity index of soil respiration component to water availability. As regard the sensitivity of microbial respiration to soil moisture was much higher than that of root respiration component.