

Bouma, T.J., Nielsen, K.L., Eissenstat, D.M. and Lynch, J.P. 1997. Estimating respiration of roots in soil: Interactions with soil CO₂, soil temperature and soil water content. *Plant Soil* 195: 221-232

Abstract

Little information is available on the variability of the dynamics of the actual and observed root respiration rate in relation to abiotic factors. In this study, we describe I) interactions between soil CO₂ concentration, temperature, soil water content and root respiration, and II) the effect of short-term fluctuations of these three environmental factors on the relation between actual and observed root respiration rates. We designed an automated, open, gas-exchange system that allows continuous measurements on 12 chambers with intact roots in soil. By using three distinct chamber designs with each a different path for the air flow, we were able to measure root respiration over a 50-fold range of soil CO₂ concentrations (400 to 25000 ppm) and to separate the effect of irrigation on observed vs. actual root respiration rate. All respiration measurements were made on one-year-old citrus seedlings in sterilized sandy soil with minimal organic material. Root respiration was strongly affected by diurnal fluctuations in temperature ($Q_{10} = 2$), which agrees well with the literature. In contrast to earlier findings for Douglas-fir (Qi et al., 1994), root respiration rates of citrus were not affected by soil CO₂ concentrations (400 to 25000 ppm CO₂; pH around 6). Soil CO₂ was strongly affected by soil water content but not by respiration measurements, unless the air flow for root respiration measurements was directed through the soil. The latter method of measuring root respiration reduced soil CO₂ concentration to that of incoming air. Irrigation caused a temporary reduction in CO₂ diffusion, decreasing the observed respiration rates obtained by techniques that depended on diffusion. This apparent drop in respiration rate did not occur if the air flow was directed through the soil. Our dynamic data are used to indicate the optimal method of measuring root respiration in soil, in relation to the objectives and limitations of the experimental conditions.