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Respiration-to-DNA ratio reflects physiological state of microorganisms in root-free and rhizosphere soil

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The double-stranded DNA (dsDNA) content in soil can serve as a measure of microbial biomass under near steady-state conditions and quantitatively reflect the exponential microbial growth initiated by substrate addition. The yield of respired CO2 per microbial biomass unit (expressed as DNA content) could be a valuable physiological indicator reflecting state of soil microbial community. Therefore, investigations combining both analyses of DNA content and respiration of soil microorganisms under steady-state and during periods of rapid growth are needed.

We studied the relationship between CO2 evolution and microbial dsDNA content in native and glucose-amended samples of root-free and rhizosphere soil under Beta vulgaris (Cambisol, loamy sand from the field experiment of the Institute of Agroecology FAL, Braunschweig, Germany). Quantity of dsDNA was determined by direct DNA isolation from soil with mechanic and enzymatic disruption of microbial cell walls with following spectrofluorimetric detection with PicoGreen (Blagodatskaya et al., 2003). Microbial biomass and the kinetic parameters of microbial growth were estimated by dynamics of the CO2 emission from soil amended with glucose and nutrients (Blagodatsky et al., 2000). The CO2 production rate was measured hourly at 22 using an automated infrared-gas analyzer system.

The overall increase in microbial biomass, DNA content, maximal specific growth rate and therefore, in the fraction of microorganisms with r-strategy were observed in rhizosphere as compared to bulk soil. The rhizosphere effect for microbial respiration, biomass and specific growth rate was more pronounced for plots with half-rate of N fertilizer compared to full N addition. The DNA content was significantly lower in bulk compared to rhizosphere soil both before and during microbial growth initiated by glucose amendment.

Addition of glucose to the soil strongly increased the amount of CO2 respired per DNA unit. Without substrate addition the VCO2-to-total DNA ratios were lower than 0.1 μg CO2-C μg-1 total DNA h-1 whereas during exponential microbial growth these values increased consistently and exceeded 1 μg CO2-C μg-1 DNA h-1. Thus, the VCO2-to-total DNA ratio strongly changes along with the physiological state of soil microorganisms and can be used as valuable physiological parameter. In growing microorganisms the quantity of CO2 evolved per unit of newly formed DNA was identical in rhizosphere and root free soil and averaged for 13.5 $\pm$ 1.1 μg CO2-C μg-1 newly formed DNA. The CO2 yield per unit of newly formed DNA allows the estimation of microbial growth efficiency and validation of specific growth rates obtained during kinetic analysis of respiration curves.

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References:

Blagodatskaya EV, Blagodatskii SA, Anderson TH. 2003. Quantitative Isolation of Microbial DNA from Different Types of Soils of Natural and Agricultural Ecosystems. Microbiology 72(6):744-749.

Blagodatsky SA, Heinemeyer O, Richter J. 2000. Estimating the active and total soil microbial biomass by kinetic respiration analysis. Biology and Fertility of Soils 32(1):73-81.