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Sterilization-CO_2-Injection (SCI) BaPS: Establishment of a new method to measure rates of soil respiration and gross nitrification in calcareous agricultural soils

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Soil respiration and nitrification are key processes in carbon and nitrogen cycling in soil. An exact measurement of these two processes is a prerequisite for understanding the release of trace gases from soils. During the last decades the Barometric Process Separation (BaPS) method has become a widely used method to measure the turnover rates of these two processes. Its application, however, is currently limited to acidic to slightly acidic soils. In calcareous soils huge amounts of CO_2 from soil respiration are dissolved in the soil solution, and the application of the BaPS method is hampered by the exact quantification of this flux. Small errors in this flux may result in huge errors in the calculation of the nitrification and respiration rates.
In order to overcome this shortcoming and to extend the applicability of the method to a wider range of soils (especially agricultural soils) we developed a new adaptive method, the Sterilization-CO_2-Injection (SCI) method, which aims to determine the CO_2 dissolution flux (CO_2,aq) experimentally. Therefore, an additional measuring step is introduced in which a sterilized soil subsample is incubated in the BaPS apparatus and known amounts of a pure CO_2 gas are injected into the system while CO_2 partial pressure is monitored. After each injection peak CO_2 partial pressure decreases until a new stable equilibrium concentration is reached. This behavior is used to compute the amount of CO_2 transferred to the soil solution applying simple mass balance calculation. The paired information about CO_2 and CO_2,aq is used to derive a regression equation, which gives CO_2,aq as a function of the CO_2 partial pressure. This relation is further used within the standard BaPS method.
Results of the SCI-BaPS method for gross nitrification rates will be presented and compared to data measured by the 15N pool dilution method (Kirkham and Bartholomew, 1954). Results were obtained with calcareous and acidic agricultural soil samples. It turned out that with the acidic soils no significant differences in the nitrification rates between the standard BaPS method and the SCI-BaPS method were found whereas with calcareous soils nitrification rates calculated with the standard BaPS method were 60 to 180% higher than the nitrification rates measured with the SCI-BaPS. Comparing SCI-BaPS nitrification rates with 15N pool dilution results, with all soils BaPS rates were always higher than 15N rates, which suggests a systematic overestimation due to the utilization of an inadequate respiration quotient (RQ = dCO_2,R/dO_2,R = 1). For all soils the RQ values were adjusted such that BaPS nitrification rates matched the 15N rates (Müller et al., 2004). This procedure yielded a mean optimum RQ value of 0.9. After this adjustment both methods yielded comparable results. Further, temperature and moisture dependency of the CO_2,aq flux and dissolution dynamics were studied and will be presented.