Simultaneous determination of molecular nitrogen (N_2) and nitrous oxide (N_2O) in biochar-treated arable soils

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ABSTRACT

The long-term effects of biochar (BC) application on denitrification, especially on the end product N_2, still remain unclear, amongst others due to methodological difficulties. Thus, the aim of our work was (i) to investigate N_2 and N_2O emissions from BC-treated soils using the Helium gas-flow core method, which allows to measure the two gases simultaneously, and (ii) to determine potential controlling factors that might be affected by BC-application. For this, soil samples from two sites in Austria were obtained. At Traismauer, undisturbed soil samples (Cambisol, pH 7.5) were taken from three BC-treated (3 % BC) and three NPK-fertilized plots (control). At Kaindorf, two BC-compost treatments (0.5 to 1 % BC, one with additional N fertilization) and a control (Chernozem, pH 6.6) were sampled. The N gas emission rates were determined at two different water contents [Traismauer: 50 and 70 % water-filled pore space (WFPS); Kaindorf: 23 and 50 % WFPS] and at up to three different temperatures. For both sites, physicochemical and microbial properties were also measured. The BC-treated samples emitted on average more N_2 compared to the control samples except for the Kainsdorf samples at 50 % WFPS. In general, N gas emissions increased with increasing water content. For Traismauer, the highest mean N_2 emission rates were measured from BC-treated samples at 5 °C for both water contents. Gaseous N losses as N_2O were always lower compared to N_2 fluxes at both sites. For the Traismauer samples, N_2O was detected only sporadically. For the Kaindorf samples, N_2O emissions were detectable in all cases. The highest N_2O emission rates were determined from N-enriched BC-treated samples. The N_2:N_2O ratio ranged from 3.3 to 38.3. The physicochemical and microbial properties determined could not explain the differences in N gas emission rates.