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Impact of two different types of grassland-to-cropland-conversion on dynamics of soil organic matter mineralization and N2O emission

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Conversion of grassland to arable land often causes a decrease of soil organic matter stocks and it increases nitrate leaching and the emission of the greenhouse gases CO_2 and N2O. Conversion methods which minimize the mechanical impact on the surface soil may reduce mineralization rates and greenhouse gas emissions. We determined the effect of two different types of grassland to maize conversion (a) plowing of the sward followed by seeding of maize and (b) chemical killing of the sward by glyphosate followed by direct seed of maize) on the mineralization of grassland derived organic matter, the release of nitrate and the emission of N2O. The field experiment was carried out at the research station Kleve which is located in North Rhine-Westphalia, Germany.
A four times replicated plot experiment with the following treatments was set up in April 2010: (i) mechanical conversion of grassland to maize (ii) chemical conversion grassland to maize and (iii) continuous grassland as reference. Nitrogen fertilization was 137 kg N ha-1 for maize and 250 kg N ha-1 for grassland.
Soil respiration and emission of N2O were measured weekly for one year using manual closed chambers and gas chromatography. Emission of CO_2 from mineralization of grassland-derived organic matter was determined from the δ13C signature of soil respiration. Soil respiration was mainly fueled by mineralization of grassland-derived organic carbon. There was no effect of the type of grassland conversion on total mineralization of organic matter originating from grassland.
Both grassland to maize conversion treatments exhibited very high soil nitrate concentrations one year after grassland conversion (about 250 kg NO_3-N in 0 – 90 cm). Total N2O emission decreased in the order chemical conversion of grassland (25.5) > mechanical conversion of grassland (20.1) > permanent grassland (10.8). Emissions were highest after harvest of maize when soil moisture increased.
The results show that both types of grassland-to-maize conversion resulted in a large surplus of soil nitrate which promotes nitrate leaching to the groundwater and indirect N2O emissions. In addition, it caused high direct N2O emissions. We found no evidence that grassland conversion without mechanical plowing is an option to reduce groundwater contamination and greenhouse gas emission to the atmosphere.