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Greenhouse gas fluxes during growth of different bioenergy crops

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Bioenergy crops are expected to contribute to greenhouse gas mitigation by substituting fossil fuels. However, during production, processing and transport of bioenergy crops greenhouse gas emissions are generated that have to be taken into account when evaluating the role of bioenergy for climate mitigation. Especially nitrous oxide (N_2O) emissions during feedstock production determine the greenhouse gas balance of bioenergy due to its strong global warming potential. This fact has often been ignored due to insufficient data and knowledge on greenhouse gas emission from cropland soils under bioenergy production. Therefore, we started to investigate the greenhouse gas emissions of major bioenergy crops maize, oil seed rape, grass (grass-clover, without N-fertilizer) and short rotation coppice (SRC, poplar hybrid) at two sites in Central Germany (near Göttingen and in Thuringia). The nitrous oxide and methane (CH_4) fluxes from these sites have been determined by weekly chamber measurements since May 2011.

The N_2O emissions from all fields were low and without extreme peaks during the first five months of measurement (222 to 687 g N_2O-N ha^{-1} for 5 months). The rape field near Göttingen emitted less N_2O than the SRC, probably because SRC was newly established in spring 2011 and the rape has not been fertilized during the measurement period (cumulative emission over 5 months: rape seed 366 $\pm$ 188 g N_2O-N ha^{-1}, grassland 497 $\pm$ 153 g N_2O-N ha^{-1}, SRC 687 $\pm$ 124 g N_2O-N ha^{-1}). The maize field in Thuringia emitted more N_2O than the SRC due to emission peaks related to the fertilization of maize (cumulative emission over 5 months: maize 492 $\pm$ 140 g N_2O-N ha^{-1}, grasslands 253 $\pm$ 87 and 361 $\pm$ 135 g N_2O-N ha^{-1}, new SRC 222 $\pm$ 90 g N_2O-N ha^{-1}, 4 years old SRC 340 $\pm$ 264 g N_2O-N ha^{-1}). All sites showed a net uptake of atmospheric methane throughout the summer season (104 to 862 g CH_4-C ha^{-1} for 5 months). However, net-exchange of CH_4 is of little importance for the greenhouse gas budget of the anlysed crops. Emissions related to management activities and during fertilizer production have to be taken into account. Total emissions were related to the net energy yield of the different crops.

Our first results indicate that perennial crops have the potential to reduce greenhouse gas emissions from bioenergy crop production as compared to annual crops due to its lower fertilizer demand.