Nitrous oxide emissions after sewage sludge fertilization of a willow bioenergy plantation

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Project aim

To investigate the impact of sewage sludge as fertilizer on N_2O emissions from a willow bioenergy plantation.

Result summary

- The N_2O emission size is dependent on weather conditions. The timing of fertilization is therefore important for managing N_2O emissions.
- There are low excess emissions of N_2O-N after sewage sludge fertilization, despite high peak emission events.

Background

- By the year 2020, 20% of the EU's total energy consumption must come from renewable energy according to an EU directive.
- Plantations of willow (*Salix spp*) are grown in Europe today, and the biomass produced is used as a source of renewable energy.
- In Sweden, sewage sludge from sewage treatment plants is used as fertilizer after harvest of a willow plantation.
- The sludge creates a favorable environment for formation of the greenhouse gas nitrous oxide (N_2O) because of its high content of organic material, bio-available nitrogen and moist character.
- The default emission factor for direct emissions of N_2O is 1 % (IPCC, 2006).
- The impact of sludge on N_2O emissions has not yet been evaluated.

Results and conclusions

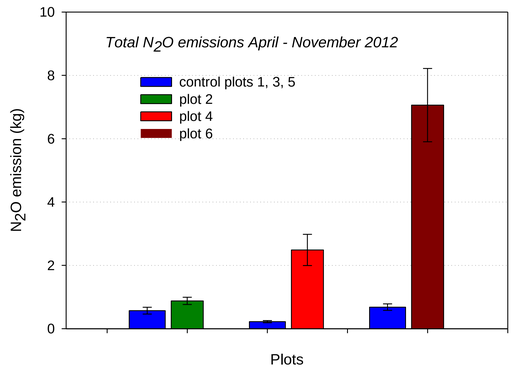

Fig. 1. Accumulated N_2O emissions, control plots (1,3,5) and fertilized plots (2,4,6).
Control plots: n1=210, n3=176, n5=211
Treatment plots: n2=210, n4=202, n6=207

Plot	Applied N (kg/ha)	Excess emissions of N_2O-N (%)	Fertilization date
2	229	0.13	May 28, 2012
4	324	0.46	May 14, 2012
6	263	1.76	May 14, 2012

Table 1. Total N applied for each fertilized plot.
Excess emissions of N_2O-N in percent.
Time period 1st April to 30th November 2012.
Treatment plots: n2=210, n4=202, n6=207

- There was a large N_2O emission peak from all plots in the middle of May (Fig. 2). Because of very little vegetation left after harvest, incoming precipitation could wet the soil thoroughly. At the same time, spring N mineralization created bio-available soil nitrogen. **These circumstances favored the formation of N_2O soil emissions from controls as well as treated plots.**
- Note however that emissions from treated plots (4 and 6) were a factor 10 higher compared to controls and plot 2 (fertilized at a later date) (Fig. 2) .
- The fertilization of plot 2 did not lead to any N_2O emissions the following weeks. This suggests that the drier weather conditions, together with the N_2O peak earlier in May connected to spring N mineralization, did not favor soil N_2O formation. The total N_2O emissions from plot 2 are close to values from control plots (Fig. 1). **All treated plots, however, show a similar pattern of N_2O emissions throughout the measurement period.**
- For plot 2 and 4, the excess emissions of N_2O-N are lower than the 1% default emission factor for N_2O (IPCC), but plot 6 shows larger excess emissions (Table 1).
- **The results highlight the importance of timing fertilization to suitable weather conditions for lower N_2O emissions.**

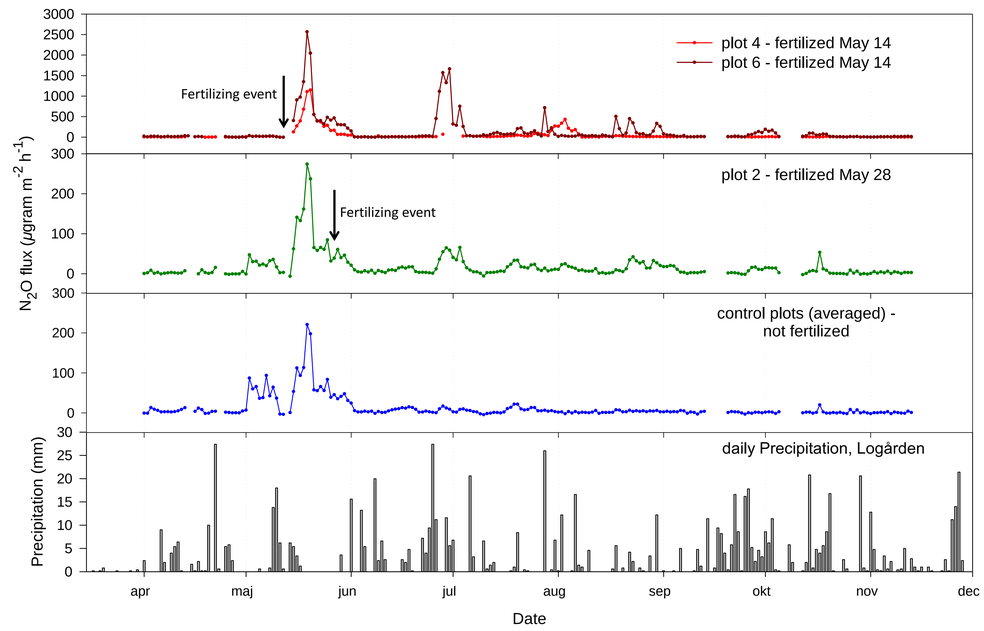

Fig. 2. N_2O emissions from controls and fertilized plots, and precipitation.

Materials and methods

The study site is a bioenergy willow plantation (2 ha) in south-western Sweden.

N_2O emissions from the soil ecosystem were continuously measured using chamber technique and a trace gas analyzer.

6 chambers were used in a rotating schedule on 3 control plots (no sludge fertilization) and 3 treatment plots (sludge fertilization).

The area was harvested in the end of March 2012, and fertilized with sewage sludge the 14th and 28th of May. Heavy precipitation during the first fertilizing event led to two different fertilizing dates.

Fertilizing event with sewage sludge in May 2012.

Chamber close-up.

Chambers measuring in the harvested field.

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