

# Reduced Tillage generates higher N<sub>2</sub>O emissions: results of continuous chamber-based measurement in a winter wheat field.

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## Objectives

- What is the impact of soil tillage on N<sub>2</sub>O and CO<sub>2</sub> fluxes?
- What is the influence of fertilization events, climate on N<sub>2</sub>O emission dynamics?



Figure 1. Gas measurement device: one set consisting of 8 chambers.

## Method

### Experimental site

- Gembloux Belgium, Silt loam region
- Crop : winter wheat
- Since 2008:
  - Crop residues return
  - Differentiated tillage
- Two parcels studied
  - Reduced Tillage (RT)**: annual stubble breaking (10 cm) and seedbed preparation (10 cm)
  - Conventional Tillage (CT)**: annual stubble breaking (10 cm), seedbed preparation (10 cm) and winter ploughing (25 cm)
- 3 fertilizations with UAN solution
  - 1: 04/ 4/02: 59 kg N ha<sup>-1</sup>
  - 2: 04/22: 66 kg N ha<sup>-1</sup>
  - 3: 05/19 : 75 kg N ha<sup>-1</sup>

### Gas Fluxes Measurements

- Continuous measurement with a high temporal resolution (4 hours).
- CO<sub>2</sub> and N<sub>2</sub>O fluxes measurement with homemade automated closed chambers
- In each parcel 8 chambers connected to CO<sub>2</sub> and N<sub>2</sub>O analyzers (figure 1)
  - Chambers close consecutively
  - 8 flux measurement per cycle
  - 1 mean flux every 4 hours

### Additional measurements

- Surface soil water content and temperature
- Every fortnight in each parcel
  - soil pH
  - soil organic carbon
  - Nitrogen pools: Total Nitrogen, NO<sub>3</sub> and NH<sub>4</sub>
- At chamber withdrawal time, beneath every chamber
  - NO<sub>3</sub>
  - NH<sub>4</sub>

## Larger N<sub>2</sub>O emissions in parcels with Reduced Tillage than in parcels with Conventional Tillage while CO<sub>2</sub> fluxes are lower (figures 2 and 3).

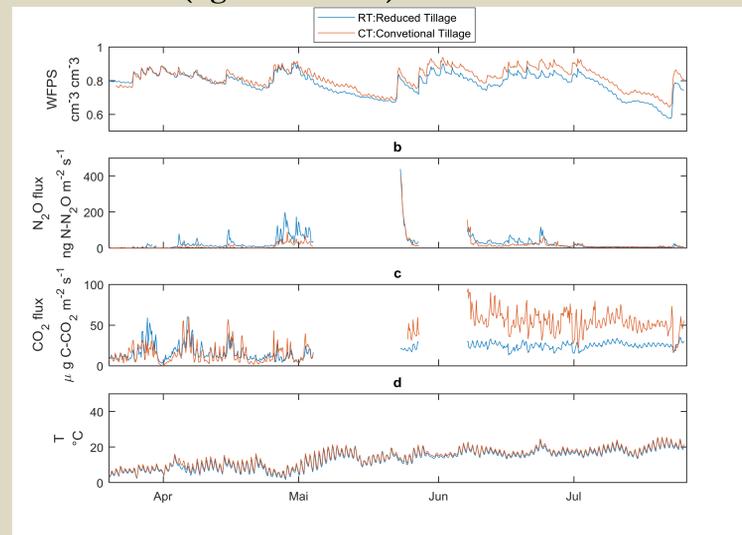


Figure 2 . Time series of water filled pore space(a), N<sub>2</sub>O fluxes (b), CO<sub>2</sub> fluxes(c) and soil temperature (d) under Reduced Tillage (RT) and Conventional Tillage (CT)

- Higher N<sub>2</sub>O emissions can be connected with the higher soil organic carbon, total nitrogen and nitrate contents in the RT parcel (figure 4).
- Differences in soil C & N content probably translate into greater microbial activity.
- On the other hand, CO<sub>2</sub> emissions are higher in the CT parcel. Residues having been included 4 months before measurements started, mineralization before the campaign might originate that difference.

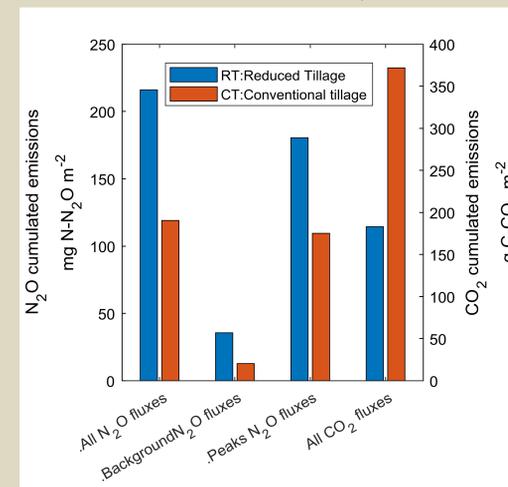


Figure 3. Cumulated N<sub>2</sub>O and CO<sub>2</sub> emissions in both treatments: Reduced Tillage (RT) and Conventional Tillage (CT).

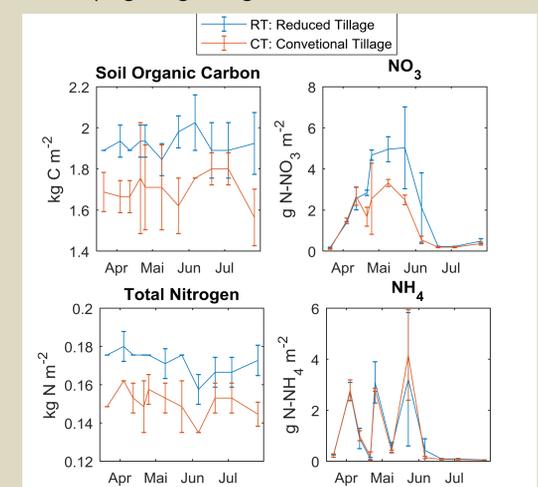


Figure 4. First 10 cm soil properties in both treatments: Reduced Tillage (RT) and Conventional Tillage (CT).

## Fertilization events and water give the rhythm to the nitrogen dynamic.

### Illustration with the RT parcel

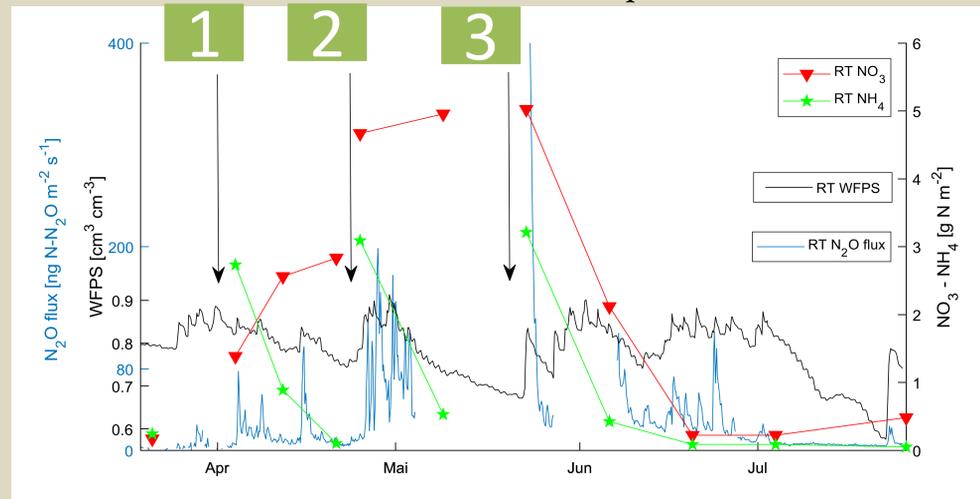


Figure 5. Time series of N<sub>2</sub>O fluxes , soil water filled pore space (WFPS) , NO<sub>3</sub> and NH<sub>4</sub> soil contents under Reduced Tillage (RT). Arrows indicate fertilization events.

- Fertilization → Input of NO<sub>3</sub> and NH<sub>4</sub>
- Post-fertilization dynamics
  - Decrease in soil NH<sub>4</sub>
  - Soil NO<sub>3</sub> still rises after fertilizations 1 & 2
  - But not after 3
- Relatively high WFPS during peak occurrences → anoxic conditions. → Denitrification episode?

## Do N<sub>2</sub>O flux peaks result from both nitrification and denitrification?

## Under Reduced Tillage: Spatial variability of N<sub>2</sub>O fluxes is related with NO<sub>3</sub> concentration in soils

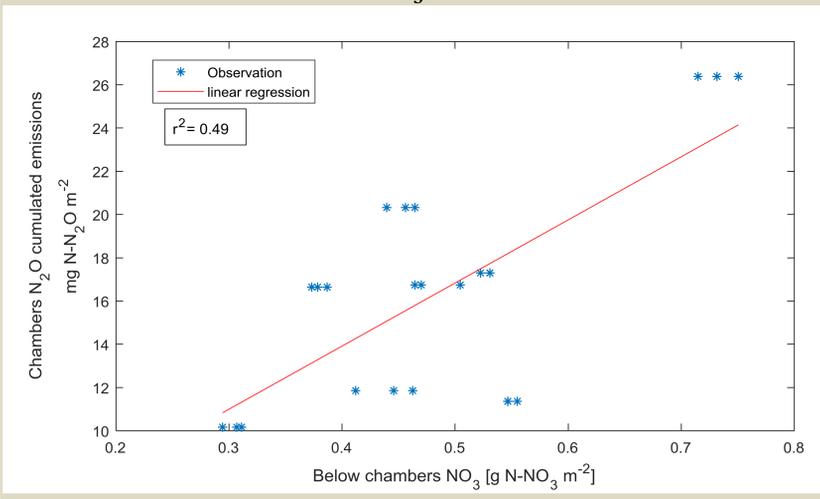


Figure 6. Relation between chamber N<sub>2</sub>O emissions (from 27/06 to 25/07) in the Reduced Tillage parcel and soil NO<sub>3</sub> content measured in the soil samples taken beneath the chambers at withdrawal time (25/07).

- At chamber scale, significant positive correlation (figure 6) between:
  - N<sub>2</sub>O emissions during last month,
  - NO<sub>3</sub>-N measured beneath the chambers at withdrawal time.
- This relation suggests nitrification process as the major source of emissions during that late period.

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