Carbon and nitrogen dynamics after destruction of a 6-year-old perennial bioenergy crop

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30/08/2016
Introduction

Switchgrass (SWI) – *Panicum virgatum*

**Perennial plant**
- High biomass production
- Low inputs

**Bioenergy crop**

Literature*: beneficial effects of this perennial crop DURING LIFE-TIME

**BUT**: how about AFTER DESTRUCTION?

- Soil organic carbon, CO\textsubscript{2} emissions?
- Nitrate leaching, N\textsubscript{2}O emissions?
- Fertilization requirements for the following crop?

Quantify soil functioning AFTER DESTRUCTION of a 6-year old perennial bioenergy crop in terms of ecosystem services:

- N-fluxes
  - N mineralization
  - N₂O emissions
- C-fluxes
  - CO₂ emissions
Experimental plan

- North of France (Estrées-Mons)
- Deep loamy soil
- SOERE ACBB
  - Long term experiment
  - since 2009

http://tab.geoportail.fr/
Comparison of two treatments

- **Switchgrass destruction** = Superficial tillage and plowing

- **After switchgrass destruction (November 2015)**
  - Monitoring on bare soil subplots for Post-SWI and Control
**Materials and Methods**

*Monitoring during 9 months*

- **NO$_3^-$ and NH$_4^+$ analyses + soil moisture (monthly)**
- **LIXIM MODEL**
  - Soil parameters: WHC, PWP, BD
  - Climatic data: T, PET, Precipitation
- **OUTPUT:** *Net nitrogen mineralization*

- **N$_2$O and CO$_2$ emissions**
  - (automatic chambers, continuously)
Results and Discussion

Lower amount of NO$_3^-$ in Post-SWI than in Control

* P < 0.05; one-factor ANOVA per sampling date
Results and Discussion

Higher amount of $\text{NH}_4^+$ in Post-SWI than in Control

* $P < 0.05$; one-factor ANOVA per sampling date
Results and Discussion

**LIXIM**: 4 times lower N-mineralization in Post-SWI than in Control

### Parameters (including)
- Soil Mineral Nitrogen
- Soil Water Content

### Flux
- Water drainage
- Leached nitrate
- Mineralized nitrogen

### Cumulative mineralized nitrogen (kg N ha⁻¹)

- Control: 112 kg N ha⁻¹
- Post-SWI: 32 kg N ha⁻¹
Results and Discussion

More cumulative CO₂ emissions in Post-SWI than in Control

Explanation

- Total biomass returned to soil (belowground + base of stems)
  Post-SWI: $31.2 \pm 7.3$ t DM ha$^{-1}$
  Control: 5 t DM ha$^{-1}$

* P < 0.05; t-test
Similar cumulative $N_2O$ emissions between Post-SWI and Control

Observed lower $NO_3^-$ content in Post-SWI between 0 and 30 cm

→ Expected lower $N_2O$ emissions in Post-SWI BUT not observed

* $P < 0.05$; t-test
Soil functioning after destruction of a 6-year old perennial bioenergy crop in terms of ecosystem services:

- N-flux  
  N mineralization: **Post-SWI < Control**
  N$_2$O emissions: **Post-SWI \approx Control**

- C-flux  
  CO$_2$ emissions: **Post-SWI > Control**
Conclusion and Prospects

Conclusion

Impacts of bioenergy crop destruction on ecosystem services?

Lower N mineralization

⇒ Less nitrate leaching BUT higher need of N inputs for the following crop

High CO₂ emissions BUT final impact on soil organic carbon unknown

Prospects

N: Yield impact on the following crop with or without N input?

C: Soil organic carbon measurements before and after destruction