

# **N<sub>2</sub>O emissions from cropping systems with integrated weed management. The nitrogen challenge: building a blue print for nitrogen use efficiency and food security**

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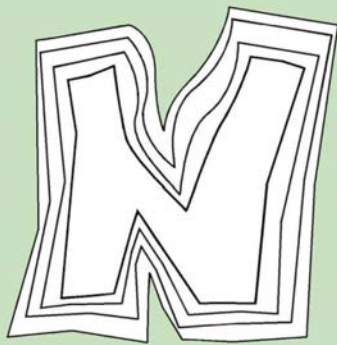
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**18th  
NITROGEN  
WORKSHOP**

**THE NITROGEN CHALLENGE:  
BUILDING A BLUEPRINT FOR NITROGEN  
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## N<sub>2</sub>O EMISSIONS FROM CROPPING SYSTEMS WITH INTEGRATED WEED MANAGEMENT

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Integrated weed management (IWM) in cropping systems aims to lower the reliance on herbicides of the crops, by introducing new combinations of agricultural practices in the system development (Munier-Jolain et al, 2009). These combinations may greatly change from a system to another and include a large variety of practices, such as false seed beds, late sowing, mechanical weeding, reduced tillage, specific crop rotations that alternate spring and winter crops, the choice of crop varieties and the use of pesticides with low ecotoxic impacts. Several implemented agricultural practices are likely to alter soil biogeochemical cycles and different components of the greenhouse gas budget (balance between the carbon sequestration and the greenhouse gas emission) of the system: e.g. crop rotation, dates and level of nitrogen fertilization and tillage. The main objectives of our study were to evaluate i) the N<sub>2</sub>O fluxes emitted from soil during one year for 4 cropping systems (i.e. 3 IWM systems and a local reference of conventional system), and ii) to investigate the relationship between the measured fluxes and soil parameters and the agricultural practices of each system.

### Materials and methods

One reference cropping system (S1) and 3 IWM cropping systems (S2, S3 and S5) were studied (Table 1). Nitrous oxide (N<sub>2</sub>O) emissions were measured continuously using the automated chamber method (Vermue et al., 2013) from March 2012 to March 2013. Soil temperature and moisture were continuously recorded for the different systems and soil bulk density and inorganic N periodically measured.

### Results and discussion

The intensity of the N<sub>2</sub>O emissions was highly variable, both over time and between systems. N<sub>2</sub>O emissions and water filled pore space (WFPS) were significantly correlated for all systems but no significant correlation could be established between N<sub>2</sub>O emissions and soil inorganic N dynamics. Over the year of experimentation, the IWM system S2 emitted significantly more N<sub>2</sub>O ( $5226 \pm 670$  g N-N<sub>2</sub>O ha<sup>-1</sup>) than the IWM system S5 ( $777 \pm 177$  g N-N<sub>2</sub>O ha<sup>-1</sup>), which also emitted significantly more N<sub>2</sub>O than the IWM system S3 ( $177 \pm 172$  g N-N<sub>2</sub>O ha<sup>-1</sup>) and the reference system S1 ( $326 \pm 168$  g N-N<sub>2</sub>O ha<sup>-1</sup>). In no-till system S2, WFPS values were significantly higher, and may have greatly enhanced the denitrification activity and the N<sub>2</sub>O fluxes emissions. The different crop rotations between systems may also have impacted N<sub>2</sub>O emissions, particularly the introduction of alfalfa, in the crop rotation of S5 system which may have enhanced N<sub>2</sub>O emissions.

### Conclusion

Over the year, the continuous monitoring of the four cropping systems allowed to identify N<sub>2</sub>O fluxes as mostly resulting from short periods of favorable soil conditions for N<sub>2</sub>O production by denitrification in soils i.e. high WFPS and temperature. Overall

the intensity of N<sub>2</sub>O fluxes significantly differed between systems, suggesting a strong impact of agricultural practices on N<sub>2</sub>O emissions. Some very high emissions, exceeding 5 kg N-N<sub>2</sub>O over the measurement period was observed on the S2 system characterized by the absence of tillage. Despite some limit of the experimental device, the results strongly suggest that a no-tilled integrated weed management system can promote N<sub>2</sub>O emissions in comparison to tilled systems either conventional or integrated. As an equivalent emission of 0.7 t C-CO<sub>2</sub> ha<sup>-1</sup> was observed to be emitted by the S2 plot, the probable carbon sequestration in this system has probably been canceled during the very rainy year of measurement. However, efficiency of no-till systems for mitigating global warming are known to increase with years, this study need to continue since the literature suggests that the observed effect of IWM on N<sub>2</sub>O emission could change overtime.

Table 1: Main characteristics of the 4 studied cropping systems (from Chikowo et al., 2009).

| Crop system      | Acronym | Description  |
|------------------|---------|--|
| Reference system | S1      | Designed to maximize financial returns. Use of chemical herbicides to control weeds. Moldboard plowing each year. Choice of herbicides according to recommendations of extension services. Crop rotation: winter wheat/winter barley/oilseed rape.   |
| IWM              | S2      | Minimum tillage between 2000 and 2007. No tillage since 2008. Time-consuming operations such as plowing, harrowing and mechanical weeding excluded. Treatment frequency index <sup>1</sup> reduced by 25 %. Diversified crop rotation <sup>2</sup> . |
| IWM              | S3      | Plowing and other tillage operations allowed when necessary for weed seedbed management but mechanical weeding is excluded. Treatment frequency index reduced by 50 %. Diversified crop rotation <sup>2</sup> + leguminous.                          |
| IWM              | S5      | Use of any herbicides excluded. Physical and cultural means are allowed to contain weed infestation. Diversified crop rotation <sup>2</sup> .  |

<sup>1</sup> amount of pesticides spread per ha expressed in % of the standard approved dosages of pesticides per ha.

<sup>2</sup> oilseed rape/winter cereal/spring crop/winter cereal/summer crop/winter cereal.

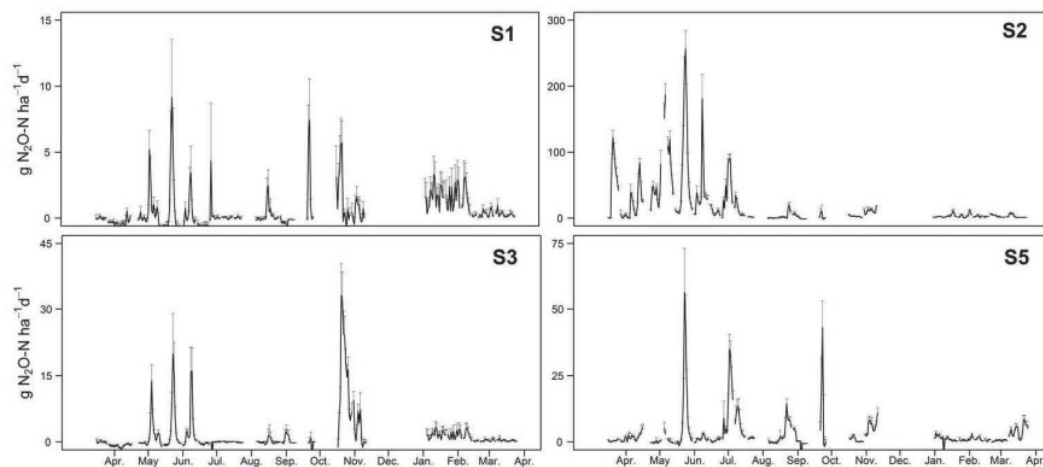


Figure 1: N<sub>2</sub>O emissions for the 4 studied cropping systems.

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