

Nitrate leaching in organic and conventional arable crop farms

Benoit M, Garnier J, Billen G
UMR METIS 7619, UPMC, Paris, France



1

Context

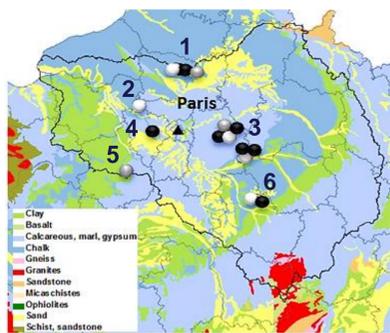
The Seine Basin, with its intensive agriculture, must also provide drinking water for the 16 M inhabitants. The issue is to maintain a sustainable agriculture with low impact on the water quality (pesticide and nitrate). Organic farming (OF) has the advantage not to use pesticide, however its impact on nitrate leaching, unknown, is controversial.

Objective

The goal of this study is to evaluate nitrate leaching in various commercial OF and conventional farming (CF) in different climate-soil conditions, in the Seine Basin.

2

An experimental network, with farmers



- Oise**
Farms (2 OF + 2 CF), Water inflow : 111 mm
- Val d'Oise**
Farm (1 OF), Water inflow : 34 mm
- Seine&Marne (S&M)**
Farms (3 OF + 5 CF), Water inflow : 30 mm
- Yvelines**
Farm (1 CF), Water inflow : 97 mm
- Centre**
4 fields (3OF + 1 CF), Water inflow : 49 mm
- Yonne**
Farms (1 OF + 1 CF), Water inflow : 41 mm

Fig.1 Location of the farms in six pedo-climatic sites (2013-14)

Table 1. Equipment of farms with ceramic cups

Equipment	7 OF rotations and 9 CF rotations 80 fields with 6 vertical ceramic cups (90cm) A total of ~580 ceramic cups
Sampling	Every two weeks during 4 months (8-10 sampling dates)
Water analysis	Nitrate (NO_3), nitrite (NO_2), ammonium (NH_4)
Soil analysis	Soil organic matter (SOM), soil mineral nitrogen (SMN), humidity, pH, total nitrogen (N)

4

Conclusion

N contamination on sub-root water decreases with :

1. Low water inflow
2. Long and diversified rotations with catch-crops
3. Low N inputs and good managements of legumes

Better N management is possible in OF systems :

- Applications of organic fertiliser in spring or before catch-crops in fall
- Alfalfa cuts exported and no fertilisation after legumes

Perspectives

- Continuing field experimentations (e.g. climatic interannual variations)
- Comparing observed data with theoretic N balance (surplus)
- Providing recommendations and testing innovative practices

3

Results at different scales

A. Farms sub-root concentrations

A high variability of sub-root concentrations in OF and CF farms (Fig. 2) which involves practices analysis

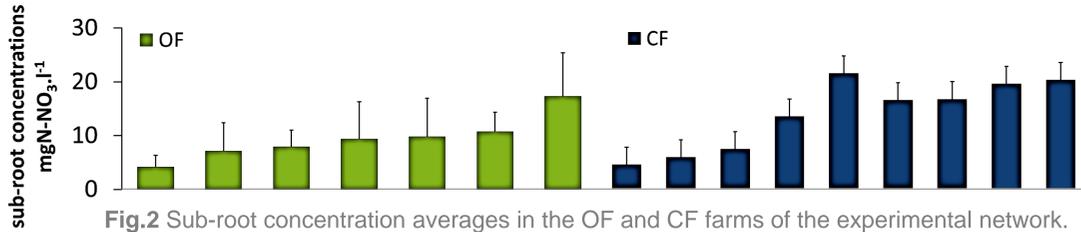


Fig.2 Sub-root concentration averages in the OF and CF farms of the experimental network. Standard deviations (SD) show the different fields equipped in each farm.

B. Fields sub-root concentrations

All plots are classified according to : 9 years OF rotation and typical CF crops (Fig. 3)

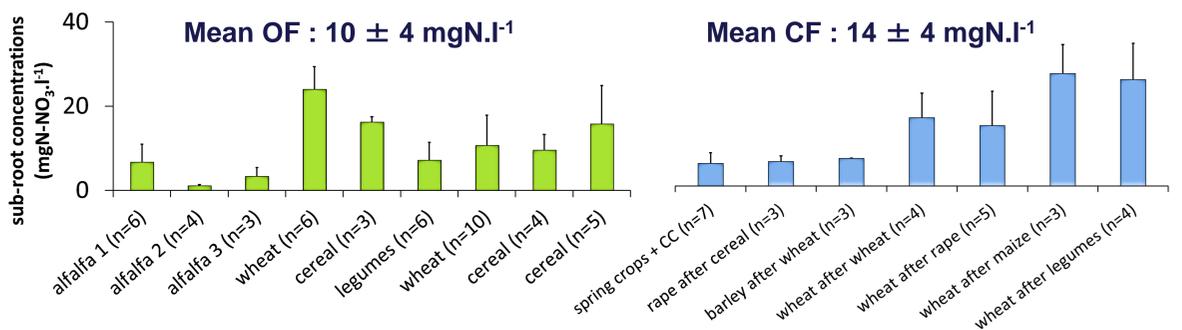


Fig.3 Sub-root concentrations for OF crops (left) and CF crops (right). SD show the different fields for a same crop in the different farms and regions.

OF rotation has a lower impact on N contamination than CF rotation

N contamination depends on :

1. Crops and previous crops : alfalfa < rape, barley < ... < crops after legumes*
2. Soil Mineral Nitrogen (SMN) before winter
3. N inputs by biological N fixation (BNF)* and fertilisation (date, type, dose)**

* Legumes can lead to important SMN in soil, but sub-root concentrations < 40 mgN- NO_3 .l⁻¹ (Fig. 4)

** Organic fertilisers do not have the same impact : liquid manure > compost > digestate + CC (Fig. 5)

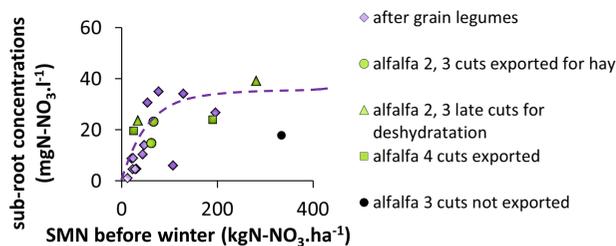


Fig.4 Sub-root concentrations and SMN of crops after legumes with different managements

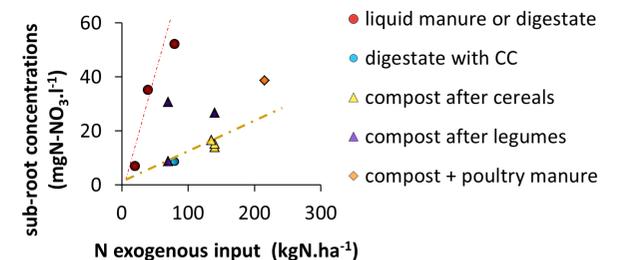


Fig.5 Sub-root concentrations of crops (OF/CF) with organic fertilisers applied in fall.

C. Sub-root concentrations and leaching at regional scale

OF vs CF leaching are only valid in a same soil-climate conditions due to

- Important variations in sub-root concentrations between sites (soils, practices, rotations, etc.) e.g. S&M : CF ≈ OF whereas in Oise : CF > OF (Fig. 6a)
- Water inflow variations. For 2013-14 : Yvelines, Oise > Yonne, S&M, Val d'Oise (Fig. 6b)

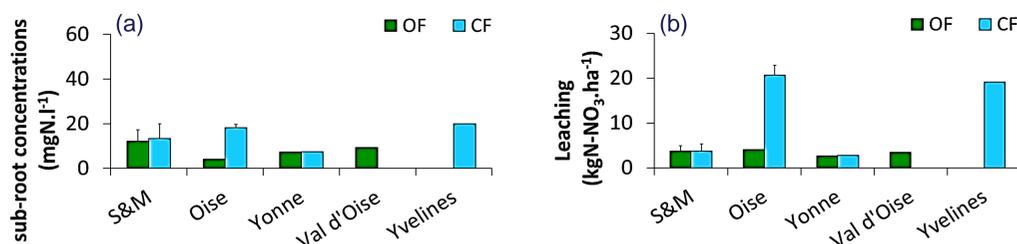


Fig.6 Mean sub-root concentrations (a) and leaching (b) for full OF/CF rotations in 5 regions. SD show the different farms in each region.

Many thanks to the farmers for their active participation. Thanks to Anun, Abdel, Benjamin and Gilles for their technical assistance in the lab and on the field.