Projet ECOSOM-SNOWMAN

SNOWMAN NETWORK
Knowledge for sustainable soils

Effects of repeated organic waste applications on soil micro-organisms involved in N cycle and their activities at the plot scale

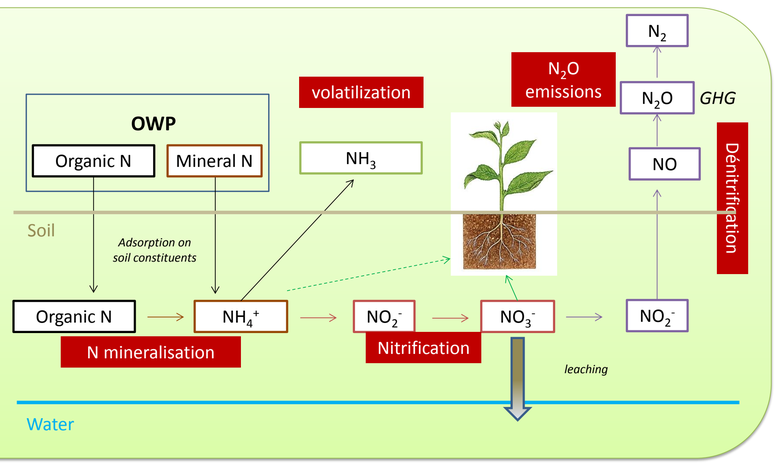
Fiona Obriot[1,2] (fobriot@grignon.inra.fr), Laure Vieublé-Gonod [2,1], Olivier Crouzet[3], Laurent Philippot[4],Sabine Houot[1,2]
[1] INRA, UMR 1091 Environment and arable crops, 78850, Thiverval-Grignon, France
[2] AgroParisTech, UMR 1091 Environment and arable crops, 78850, Thiverval-Grignon, France
[3] UMR INRA, Physical Chemistry and Ecotoxicology Research of Soil Contaminated Agrosystems, 78000, Versailles
4 UMR INRA, Soil microbiology and environmental, 21000, Dijon

Introduction

Utilization in agriculture of municipal solid waste or agricultural waste as fertilizer or organic amendment in agriculture:

→ addition of mineral and organic N in soil

→ impact on N cycle and associated ecosystemic services (soil fertility, water quality, GHG emissions, climate regulation)?



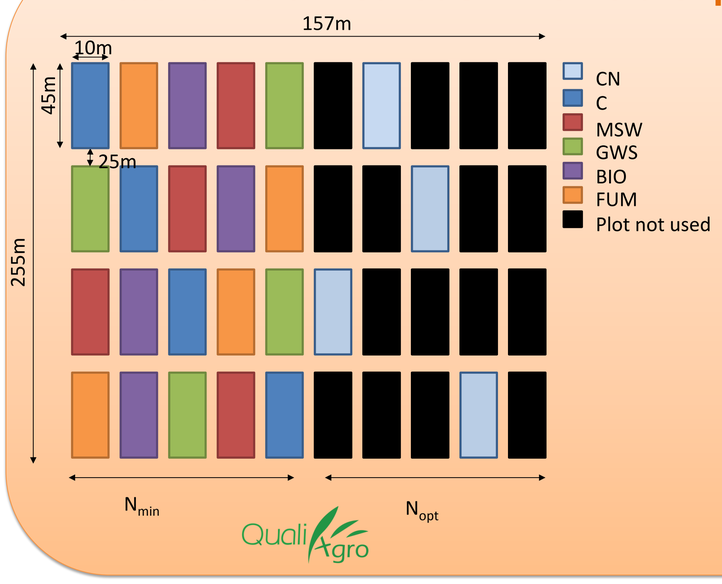
Questions

- **Short term and long term effects** of OWP amendements to soils on
  - Soil microorganisms?
  - Mineralization of organic N to mineral N?
  - Nitrifying populations and potential nitrification?
  - Denitrifying populations?

↳ N stocks in soil and potential availability of N for cultures?

- Impact **of the nature of OWP**?

Material and Methods: The field experimental site of QUALIAGRO



- Loamy soil on carbonated loess
- Initial characteristics: pH=6.9 at the start, organic N=1.1 $g.kg^{-1}$, C/N=9.5
- Crop rotation: wheat-corn (residues exported for wheat exported, incorporated for corn)
- OWP application after wheat in September **every 2 years;** Doses equivalent to **4t C/ha (10 à 20 tDM/ha)**

Treatments:
C: Control without organic waste application
CN: Control without organic waste application enriched with N
MSW: Municipal solid waste compost
GWS: Co-compost of green waste and sewage sludge
BIO: Biowaste compost
FUM: Farm yard manure

Sampling, methods and measures

2 dates of sampling:
- After 7 amendments and 1 month before the 8th one (1/09/2011) = **residual effect**
- 3 weeks after the 8th amendment (14/10/2011) = **short term effect**

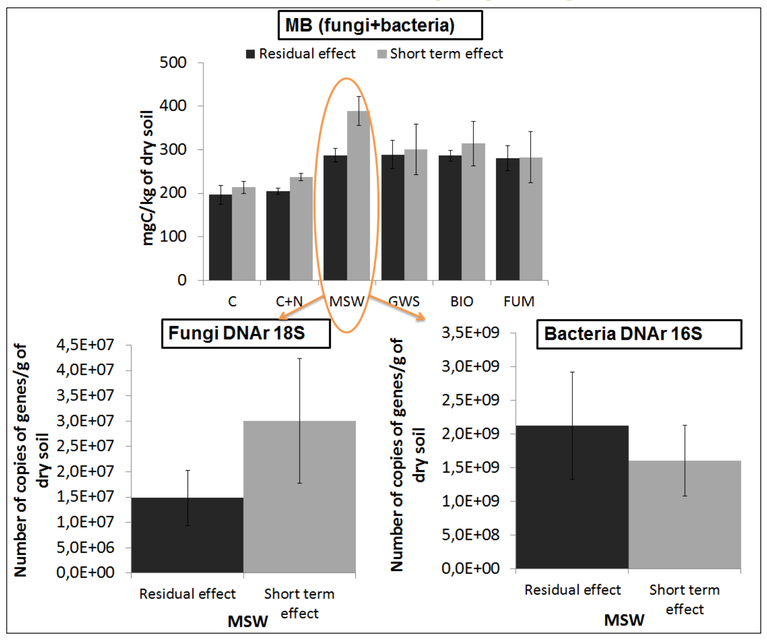
Abundance
- Microbial biomass (Fumigation-Extraction)
- Fungal (DNAr 18S)
- Bacteria (DNAr 16S)

Functional diversity
- Nitrifying populations (*amoA* qPCR)
- Denitrifying populations (*nirK* qPCR)

Potential activities
- Mineralization of N
- Nitrification

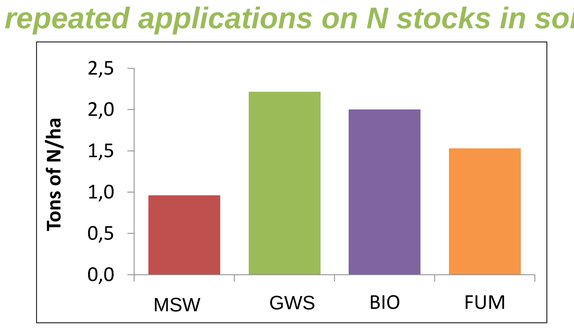
Results and Discussion

Effects on total microbial biomass (MB), fungi and bacteria



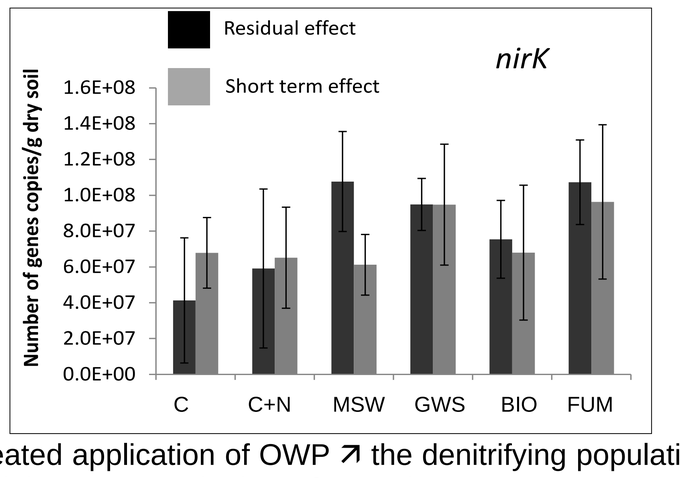
- ↗ of MB in the amended compared to control treatments just after the amendment application to soil (short term effect).
- Effect that persists with time (residual effect).
- Effect dependent on the type of OM and max with the MSW compost 3 weeks after application (high concentration of easily degradable organic C) → stimulation more specifically of fungi.

Effects of repeated applications on N stocks in soil



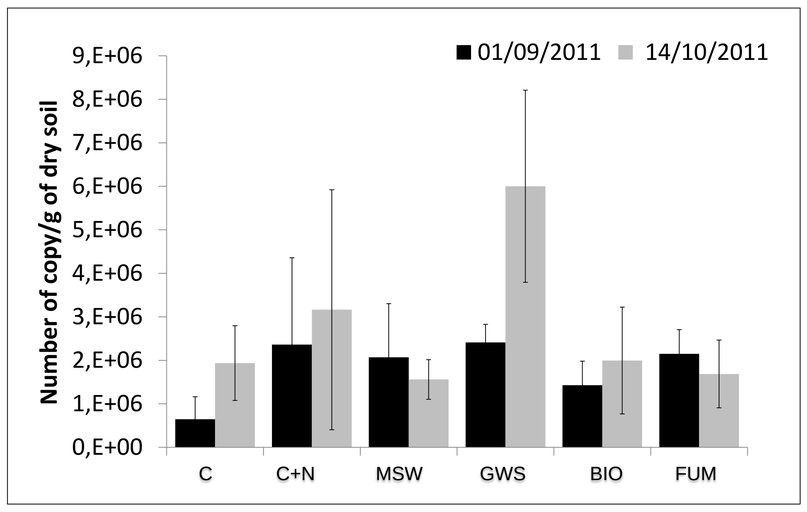
- 7 applications of organic amendments → ↗ of total N in soil: 1 to 2.2 t/ha = 47 to 90% of N added by OWP in the ploughed layer.

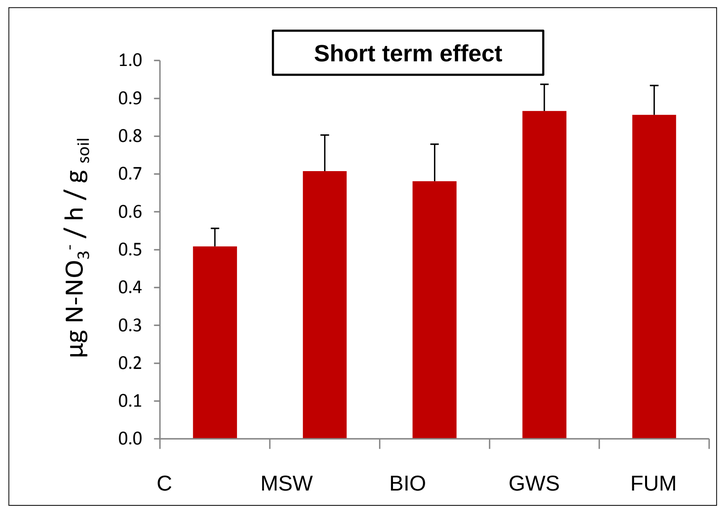
Denitrifying populations



- Repeated application of OWP ↗ the denitrifying populations with higher contents in the MSW and FUM treatments.
- No short term effect.

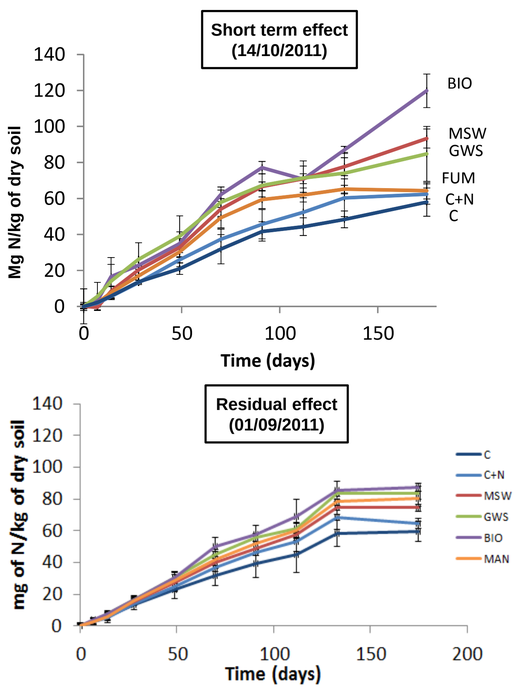
Effects on nitrification





- Short and residual effects on nitrifying populations.
- Maximal effect with the GWS compost that presents the largest concentrations in nitrogen (25.7 g N/kg DM) and particularly in ammonium (20%).
- Recent addition of OWP and especially GWS & FUM→ ↗ nitrification.

Effects of repeated and last applications on N mineralization (mg N/kg soil) ➔ kgN/ha



	MSW	GWS	BIO	FUM
Mineral N resulting from mineralization of organic N after 7 applications (residual organic N, sept. 2011)	58	93	106	79
Mineral N measured 3 weeks after the last application = mineral N added with OWP + mineral N from mineralization occurred during this period (short term effect, oct. 2011)	3	180	31	30
Mineral N resulting from mineralization of organic N added with the last amendment (short term effect, oct. 2011)	72	5	126	-60
Total (kg/ha) = mineral N supplement potentially available between 2 applications	**133**	**278**	**263**	**49**

- Long-term effect: 6% total soil organic N mineralized.
- Short-term effect: about 40% of applied N available during the year after application for composts: mostly due to mineral N and organic N mineralized immediatly after spreading for GWS; due to organic N mineralization for MSW and BIO.
- No additional N mineralized at short term in FUM.

Conclusions & perspectives:

- OWP application → **stimulation of growth and activities** of total and specific microorganisms involved in N cycle.
- Effects that persist more or less with time depending on **the intrinsic characteristics of OWP** → stronger (but shorter) effects with organic amendments composed of a high content of mineral nitrogen directly available for microorganisms.
- Impact of this agricultural practice on **ecosystem services** such as soil fertility.
- Need of additional results (GHG emission, potential volatilization of $NH_{3...}$) to make the balance of the practice.

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