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The significance of soil microalgae and cyanobacteria to assess pesticide stresses, in agricultural soils

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HAL Authorization

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Background

Pesticide risk assessment in agricultural soils:

Awareness of environmental contamination

- Wide range of pesticides: fungicides, herbicides, insecticides, other ...
- Persistence and transfert --> diffuse environmental contamination

Assessment of environmental impact on biodiversity

- Effects against non-target organisms and ecosystem functioning

Reliability of indicators for non-target soil biodiversity ?

- Fail to identify patterns for herbicide related-effects on commonly studied soil microbial (bacterial and fungal) communities => Few evidence of sensitive metabolic pathways

➔ **Need of bio-indicators for environmental survey of outcomes of pesticide uses**



Why soil photosynthetic microorganisms ?

- First soil microbial biofilm receiving pesticide application
- Metabolisms closely related to those of plants => herbicide target
- Many knowledges in aquatic system on herbicide-related impact

➔ An unrecognized diversity ?

- Eucaryotic microalgae (diatoms, chlorophyceae, xanthophyceae, chrysophyceae, ...)
- Cyanobacteria (nostocaceae, oscillatorialles, chlorococcales)

➔ Functional significance : aggregate stability and N2 fixation

(Metting, 1981; Pipe et Shubert 1984; Shimmel et Darley, 1985; Reisser, 2007)

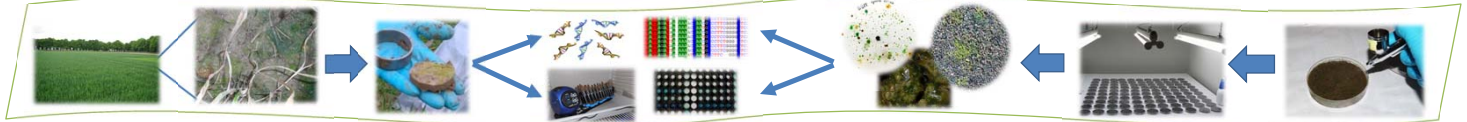
Objectives

Methodological Issues:

- Analytical methods (Biochemical and molecular markers) and experimental facilities (Soil bio-assay and microcosms) to study terrestrial systems
- Toxicity tests : what is the relevant endpoint in soils?

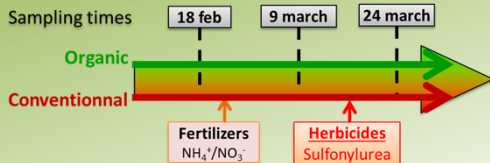
Scientific Issues:

- Improve knowledges of ecology of soil photosynthetic microorganisms.
- Direct and indirect effects of pesticides on soil microbial photosynthetic communities and delivered functions.

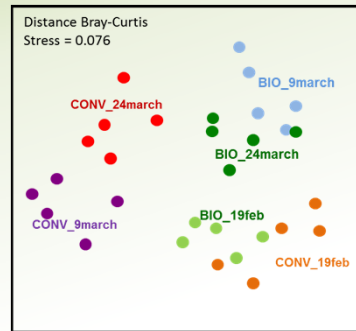


Field monitoring and community structure dynamic

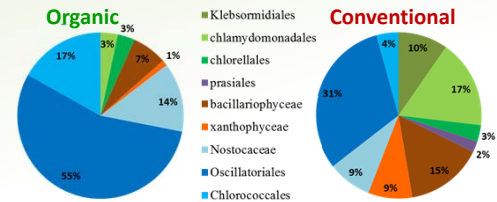
Monitoring of two cropping systems "Organic & Conventional" with various agricultural practices (La Cage, INRA Versailles)



➔ Biochemical community structure (pigments HPLC analysis)



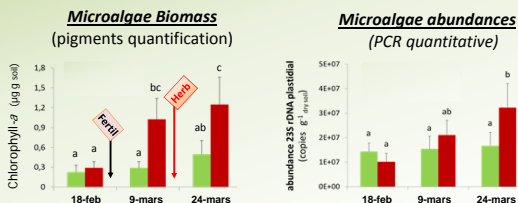
➔ Microalgae and cyanobacterial diversity (Sequencing 23S plastidial rDNA at the 24 march)



Conventional system: NPK fertilisation and no tillage during cropping period favor algae growth and diversity.

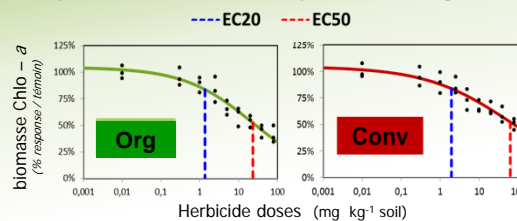
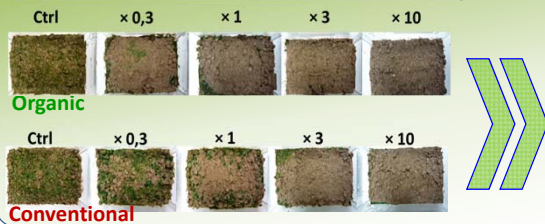
Organic system: nutrient limitation and soil surface tillage promote more competitive photosynthetic microorganisms.

➔ Quantification of photosynthetic microorganisms



Functional approach : Pollution Induced-community Tolerance (PICT)

Acute dose-effect testing tolerance acquisition to isoproturon in field samples from Organic / Conventional



➔ **EC50 org < EC50 Conv:** photosynthetic microbial communities from soil of Conv system were more tolerant to IPU.

➔ **in situ Tolerance acquisition to IPU for the photosynthetic communities from Conv soil** following repeated field annual treatment with IPU, since 10 years.

Conclusion & Perspectives:

Development of many skills to study edaphic microbial photosynthetic microorganisms

- ➔ Biochemical markers (Chlo-a and other pigments) to describ biomass response to herbicide stress (interest in mixture effects)
- ➔ Molecular makers to investigate genetic diversity (whole community or selected groups (Diatoms and Cyanobacteria))
- ➔ Functional approaches to test tolerance acquisition in response to field herbicide exposure

High significance of soil microalgae indicators ➔ Herbicides impacted the soil photosynthetic communities in the field and induced tolerance acquisition, at lower doses than it was previously observed for bacterial or fungal communities.

(Bérard et al. 2004 et Crouzet et al. 2013; Joly et al., 2015)



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