Phytoremediation assisted by arbuscular mycorrhizal fungi to clean-up dioxins/furans polluted soil of the Halluin site ?

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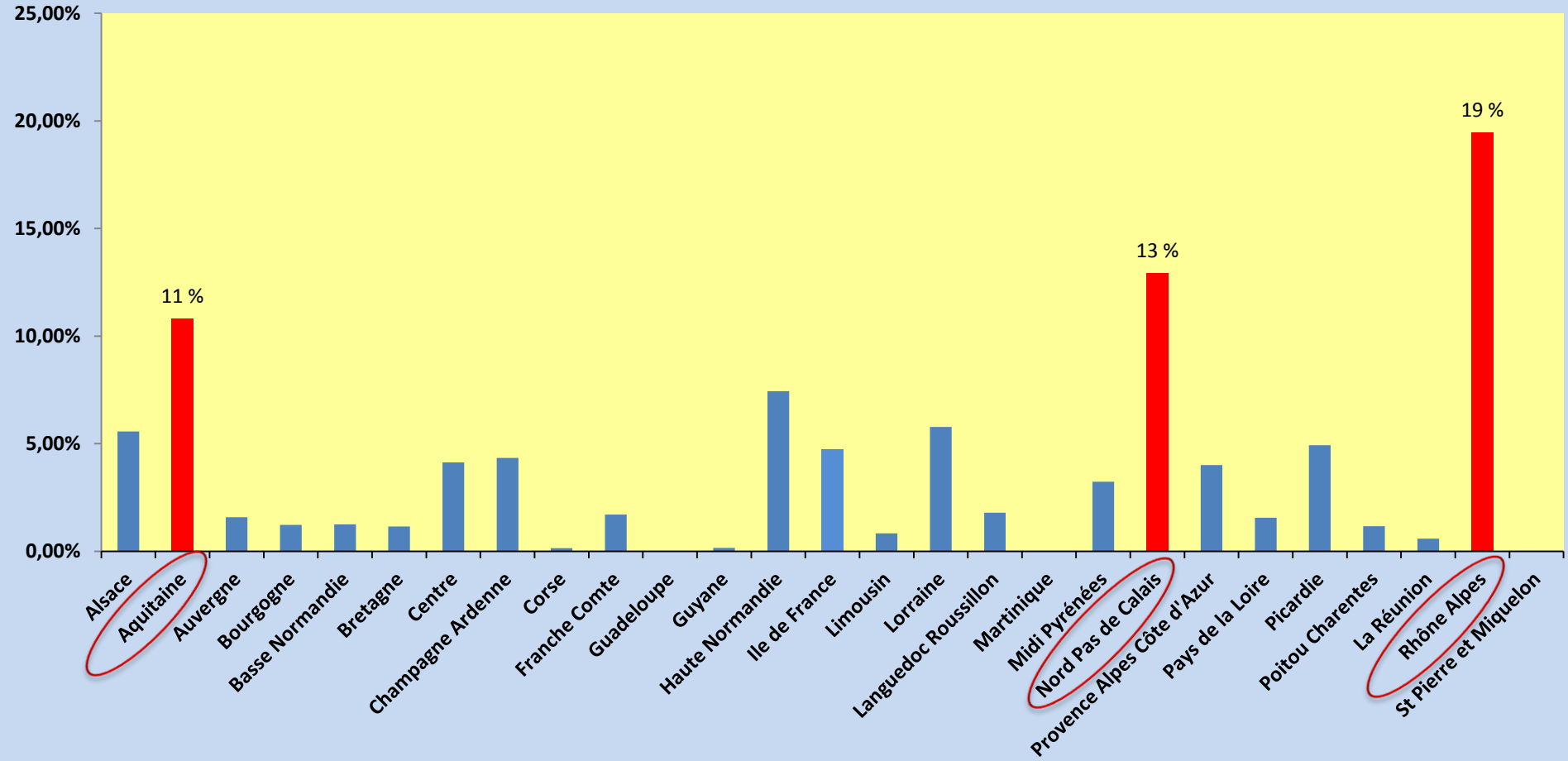
20th March 2014

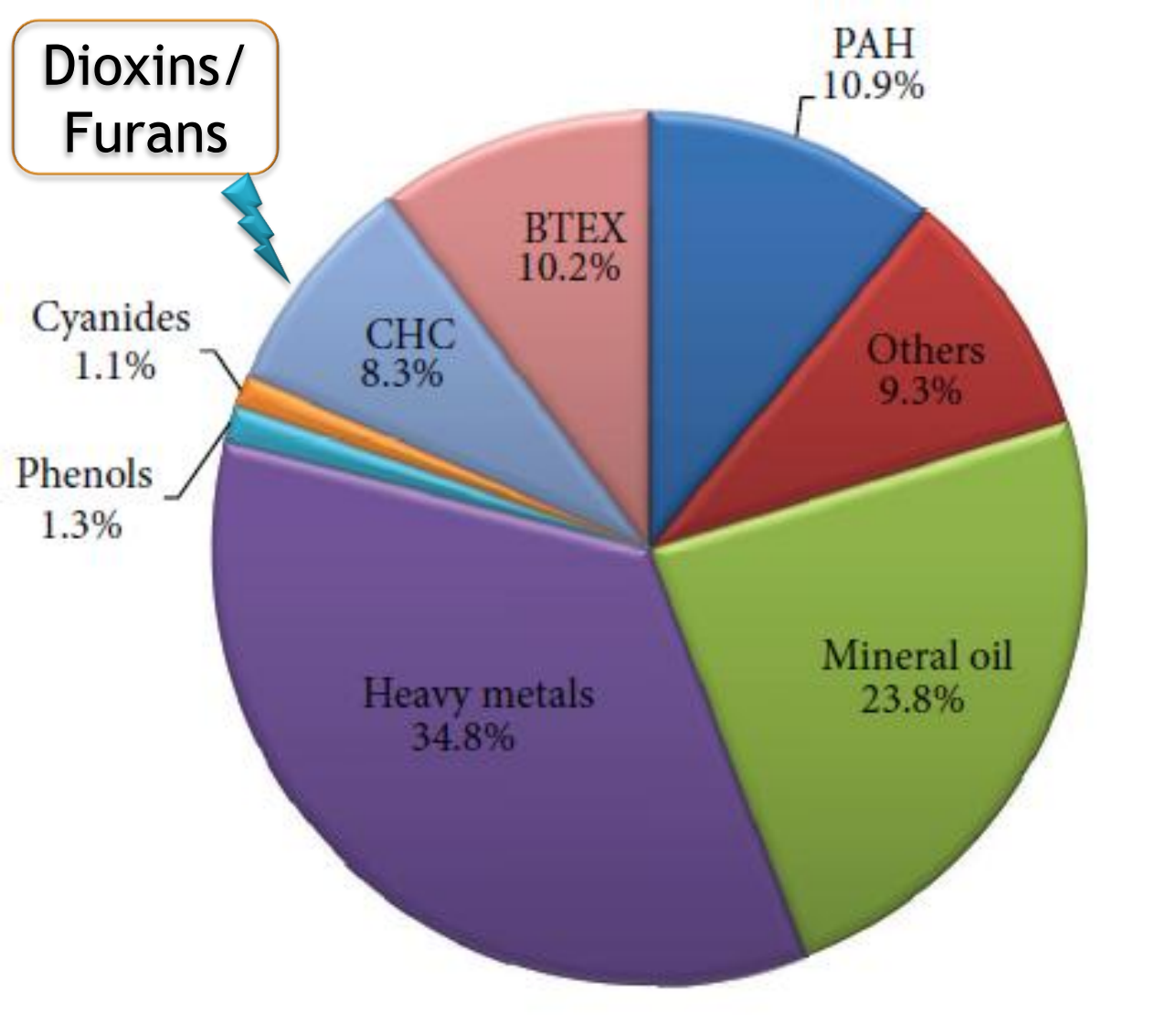
DISTRIBUTION OF CONTAMINATED SITES IN FRANCE

In Europe, about 1 170 000 sites
In France, 5137 sites and soils listed



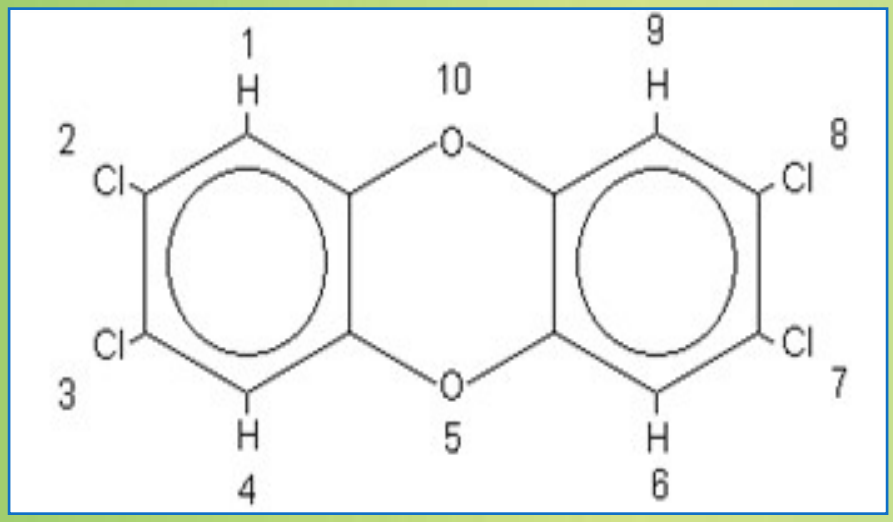
http://basol.environnement.gouv.fr (11/03/2014)

DISTRIBUTION OF CONTAMINANTS AFFECTING SOIL

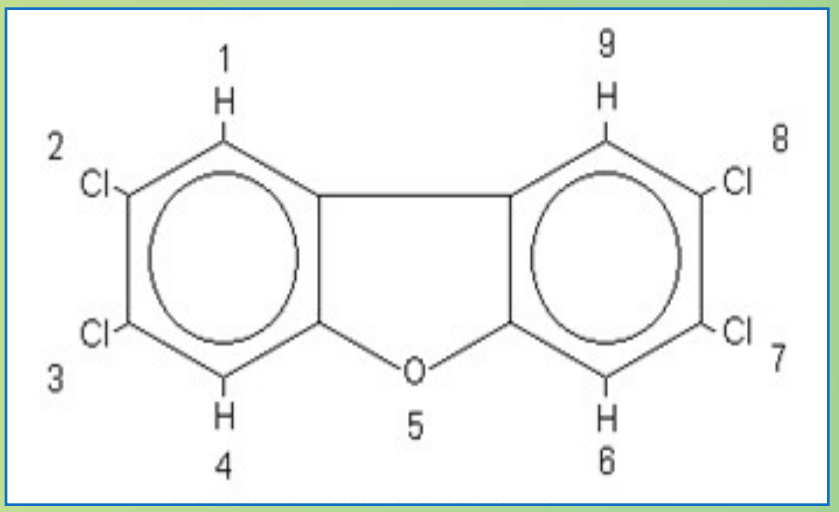


Panagos et al, 2013

DIOXINS AND FURANS



Dioxins 75 congeneres

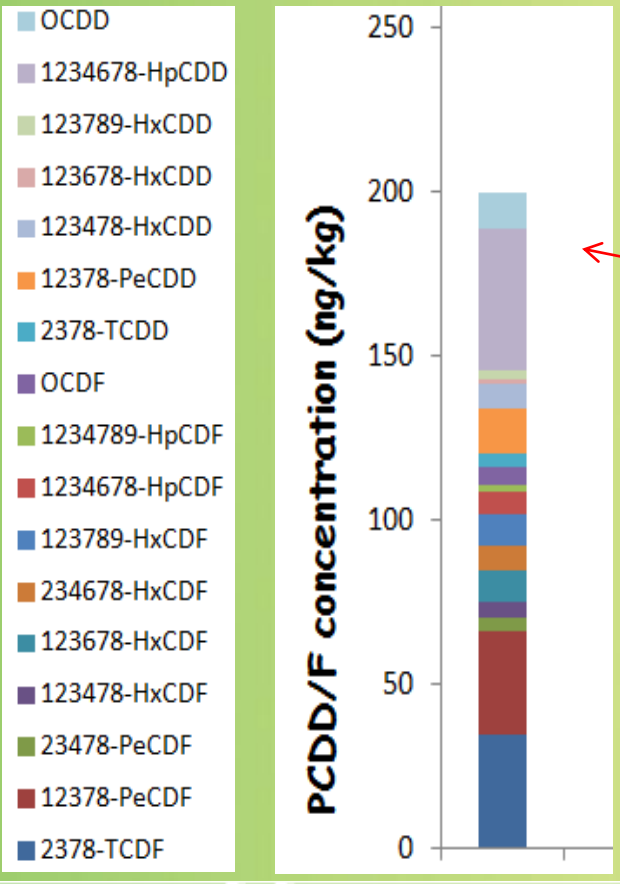


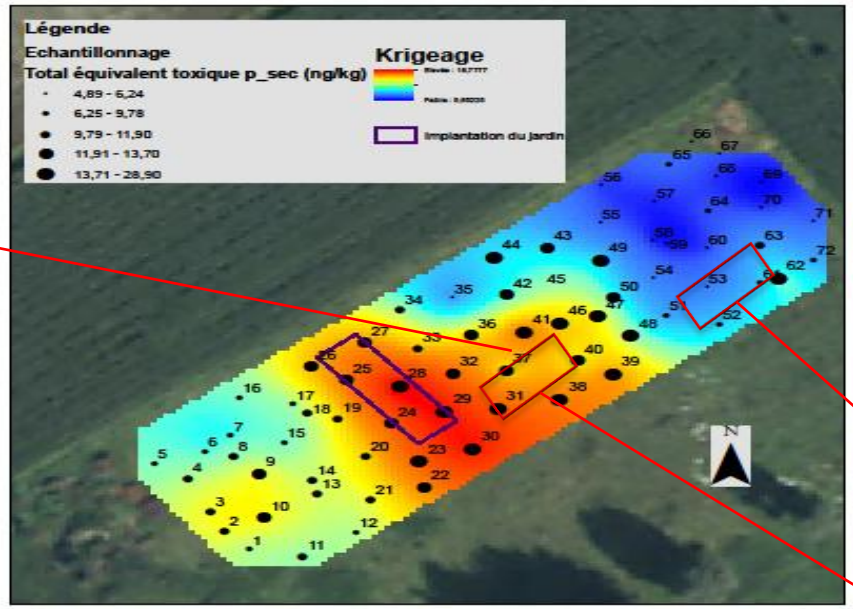
Furans: 135 congeneres

- Lipophilic, semi-volatile,
- Recalcitrant to biodegradation
- Half-life time : 10 - 100 years
- High toxicity : Cancer, neurological and immunological effects, …

PROJECT « DIOXINS : CONTAMINATION AND BIODEGRADATION »

- Coordination : Halluin 3R Association (A. Carlier)
- Funding: The Nord/Pas-de-Calais region, the European Union (PO-FEDER), ADEME, LMCU
- Experimental site: Noir Pot Farm in Halluin of 3500 m^2 historically contaminated with dioxins/ furans





Analyzes of dioxins/furans (INRA d'Arras)

Spatial analysis (INRA d'Orléans)

Contamination concentrations	+	-
PCDD/L (ng/kg)	200	58
PCDD/L (I-TEQ ng/kg)	16	5

THE “GRENELLE DE L’ENVIRONNEMENT”

Section 43 of the Grenelle II August 3, 2009

- **Management of contaminated sites and soils:**

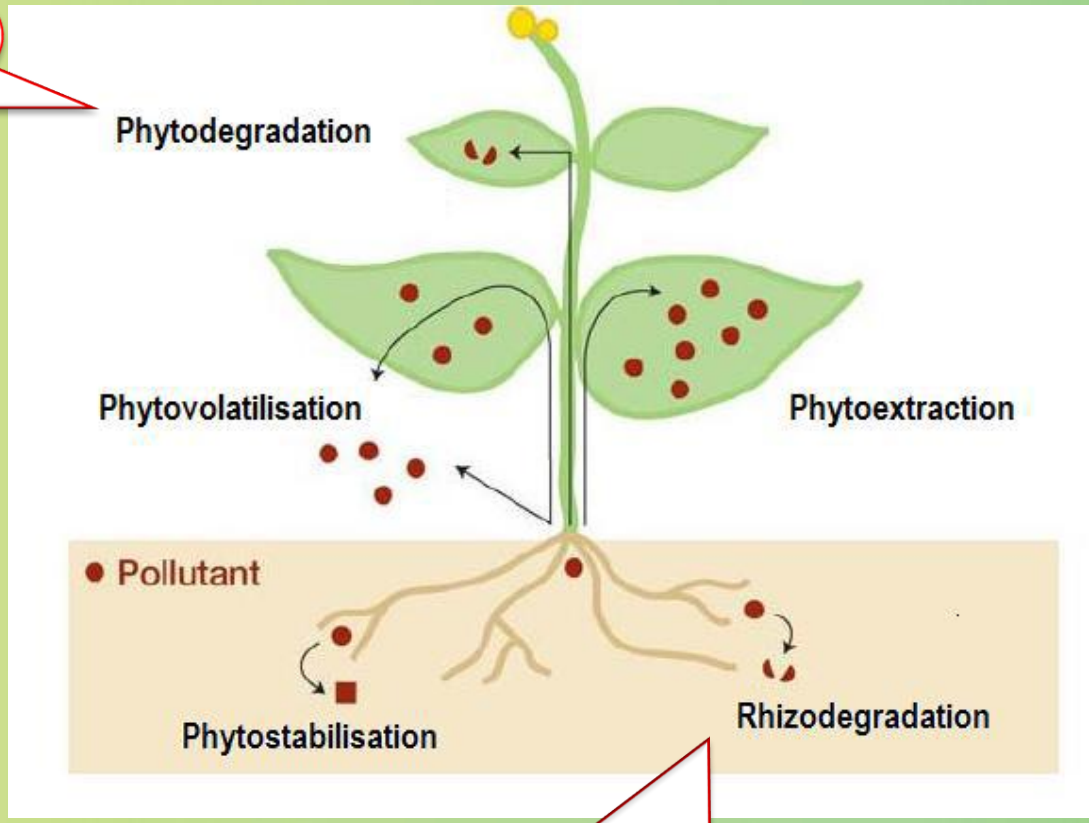
« remediation techniques by plants are preferably used »

Phytoremediation

Ministère de l'Écologie, du Développement durable et de l'Énergie

PHYTOREMEDIATION

Degradation of organic pollutants by plants



Advantages :

- Economic, Ecological
- Applicable over large areas
- Well accepted by the public
- Easy to implement

But

Phytoremediation Efficiency

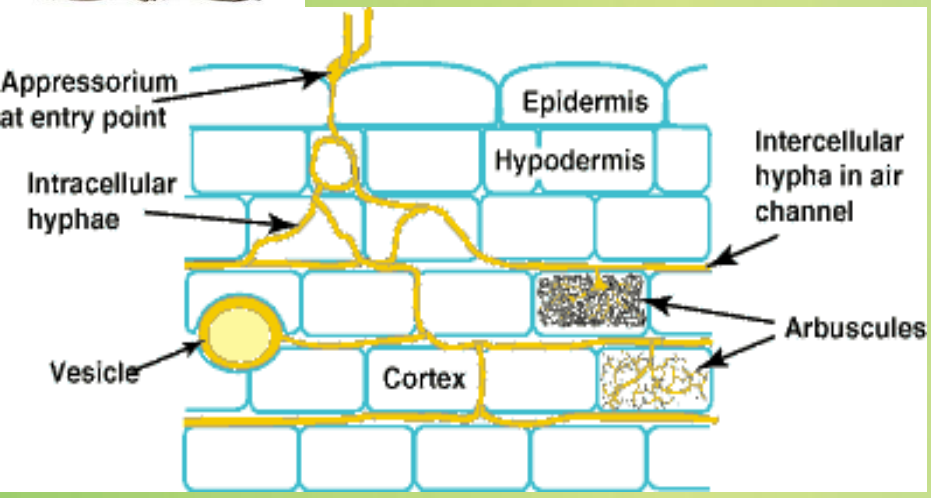
=

f (plant tolerance to pollutant toxicity)

Degradation of organic pollutants by microflora

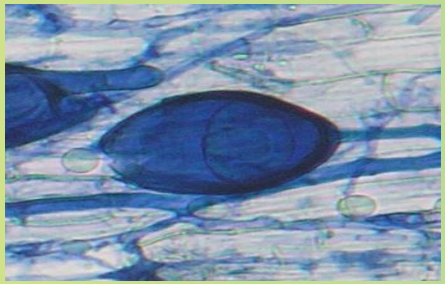
ARBUSCULAR MYCORRHIZAL FUNGI (AMF)

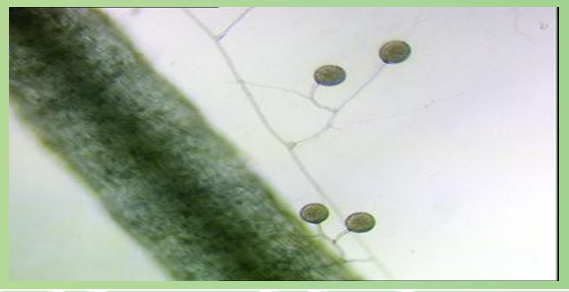
Mutualistic symbiosis association between a mycorrhizal fungus and plant roots



Arbuscular mycorrhizal fungi benefits:

- Better water and mineral nutrition
- Improve plant growth
- Better stress tolerance (biotic + abiotic)
- Better dissipation of organic pollutants





EXPERIMENTAL SET-UP

Alfalfa White clover Ryegrass Control





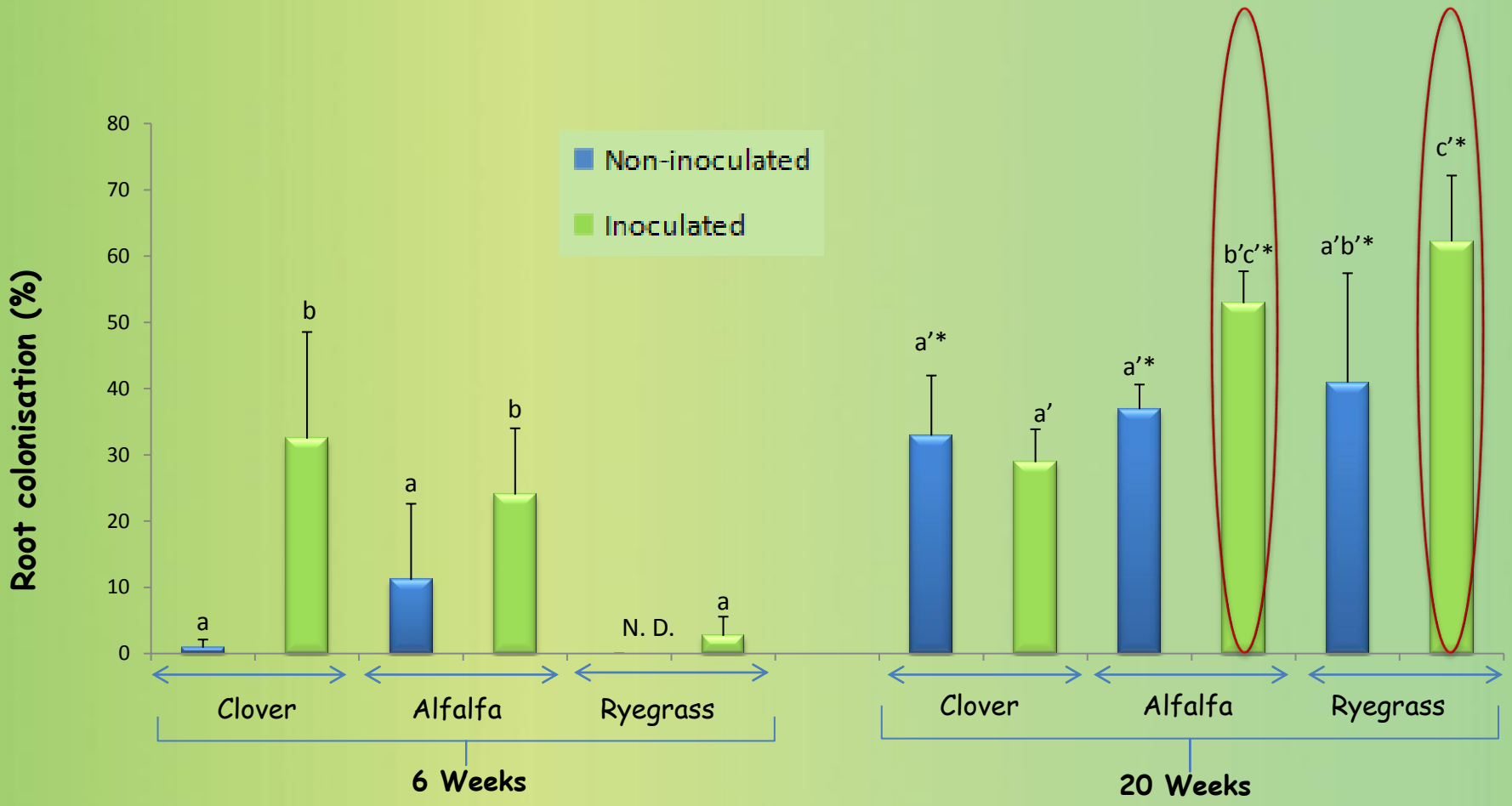
inoculated by AMF (Solrize®)

Non- inoculated

Parameters measured after 6 and 20 weeks of culture

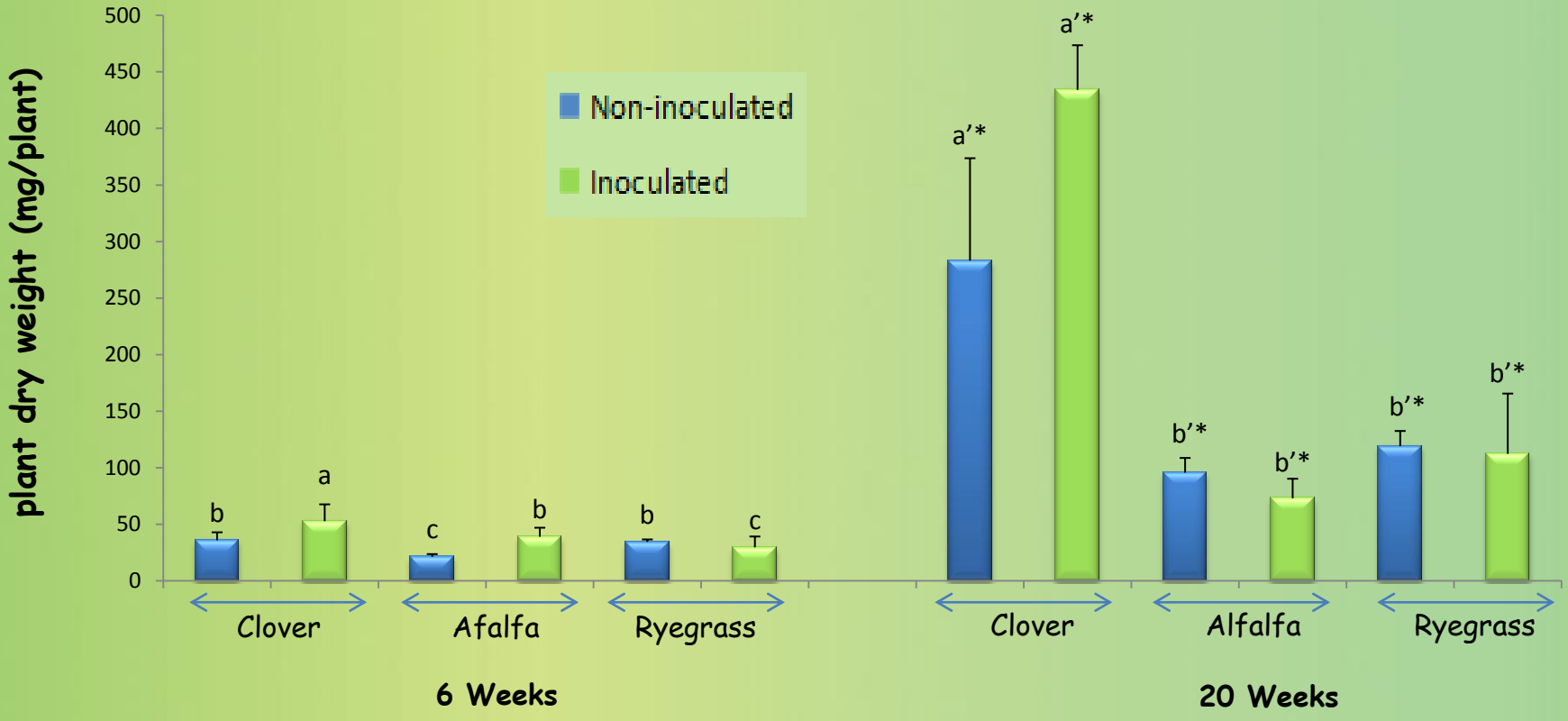
- **Plant Biomass**
- **Mycorrhization rate** (Microscopic observation)
- **Bacterial and fungal biomass** (Quantification of specific fatty acid by GC/MS)
- **Determination of residual dioxins/furans concentrations** by GC/HRMS (INRA d'Arras).

MYCORRHIZAL COLONIZATION



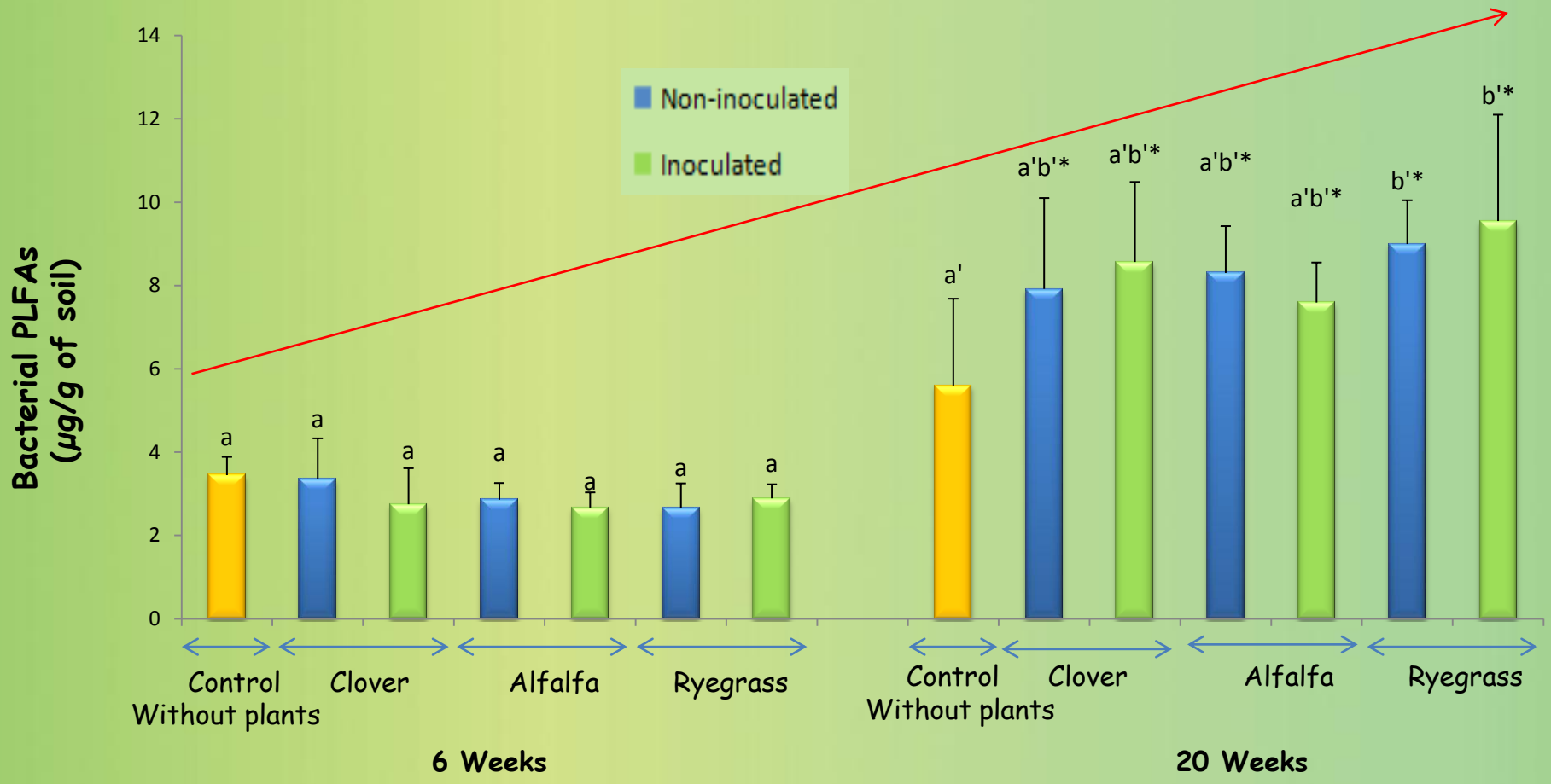
- Significant increases of mycorrhization rates after 20 weeks of culture in inoculated Alfalfa and Ryegrass

PLANT GROWTH



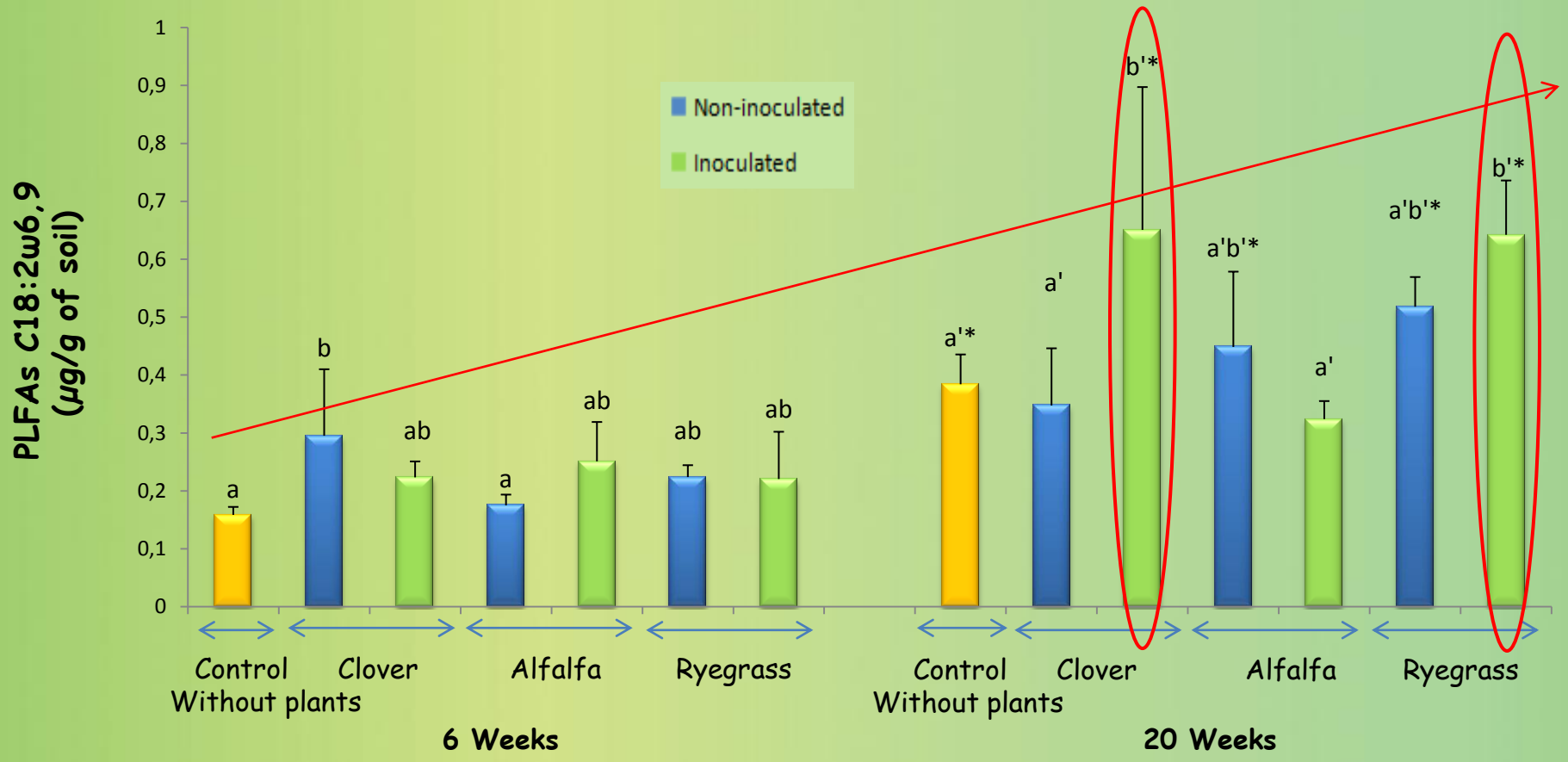
- Positive evolution of plant growth for all the plants between 6 and 20 weeks.
  - Better growth for Clover compared to Alfalfa and ryegrass.

BACTERIAL VIABILITY IN THE SOIL



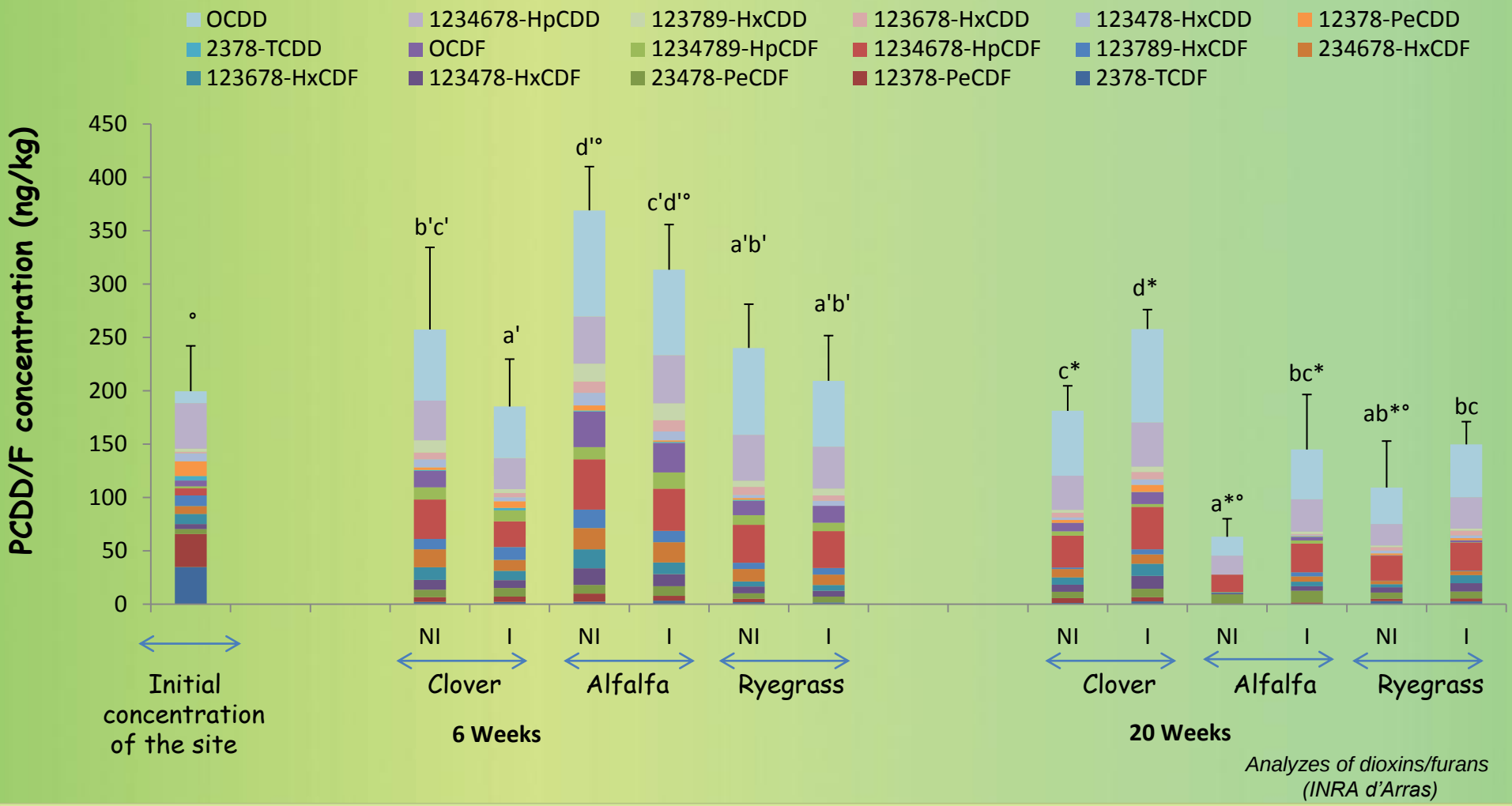
- Stimulation of bacterial biomass at 20 weeks on vegetated soil

FUNGAL VIABILITY IN THE SOIL



- Stimulation of fungal biomass at 20 weeks in particular in the presence of inoculated Clover and Ryegrass.

RESIDUAL DIOXINS/FURANS CONCENTRATIONS IN THE SOIL



Analyzes of dioxins/furans (INRA d'Arras)

- Reduced levels of dioxins/furans after 20 weeks.

CONCLUSIONS AND PERSPECTIVES

- Successful mycorrhization after addition of exogenous inoculum in the polluted soil.
- Good growth performance of the three plant species tested on the contaminated soil.
- Stimulation of the microflora (bacteria and fungi) at 20 weeks on vegetated soils, especially in the presence of Clover and Ryegrass.
- Reduced levels of dioxins/furans after 20 weeks of culture.

- Adding a biosurfactant directly or indirectly to increase the bioavailability of dioxins / furans,
- Performance evaluation and monitoring of a potential risks through ecotoxicity tests.

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Thank you for your attention

l'Europe s'engage en Nord-Pas-de-Calais avec le FEDER

RÉGION Nord-Pas de Calais

ADEME
Agence de l'Environnement et de la Maîtrise de l'Energie

Halluin 3R
Recherche · Réseau · Requalification

INRA
Institut National de la Recherche Agronomique