

Impact of transgenic crops on fertility of soils with different management history

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Motivation

- **GM-plants have a great potential to ameliorate farming systems with respect to**
 - Farm economy
 - Reduction in the use of external inputs
 - Environmental sustainability
 - **Risks of introduced gene constructs need to be evaluated thoroughly**
 - Unintended effects of GM-plants on non-target organisms, community structure, environmental stability, and human health
 - Performance and effects of GM-plants in different environments (e.g. range of sites, climatic conditions, and farming systems)
- ⇒ Case specific evaluation is necessary

Scope of the proposal in NRP 59

- **Module 1: Plant biotechnology and the environment**
 - **B) Impact of GM-plants on the environment and human health**
 - **Addressing risks (...) of GM-plants on the soil ecosystem and its biota**
 - **Degradation**
 - **Bio-geochemical cycling**
 - **Soil fertility**

Own research in soil fertility

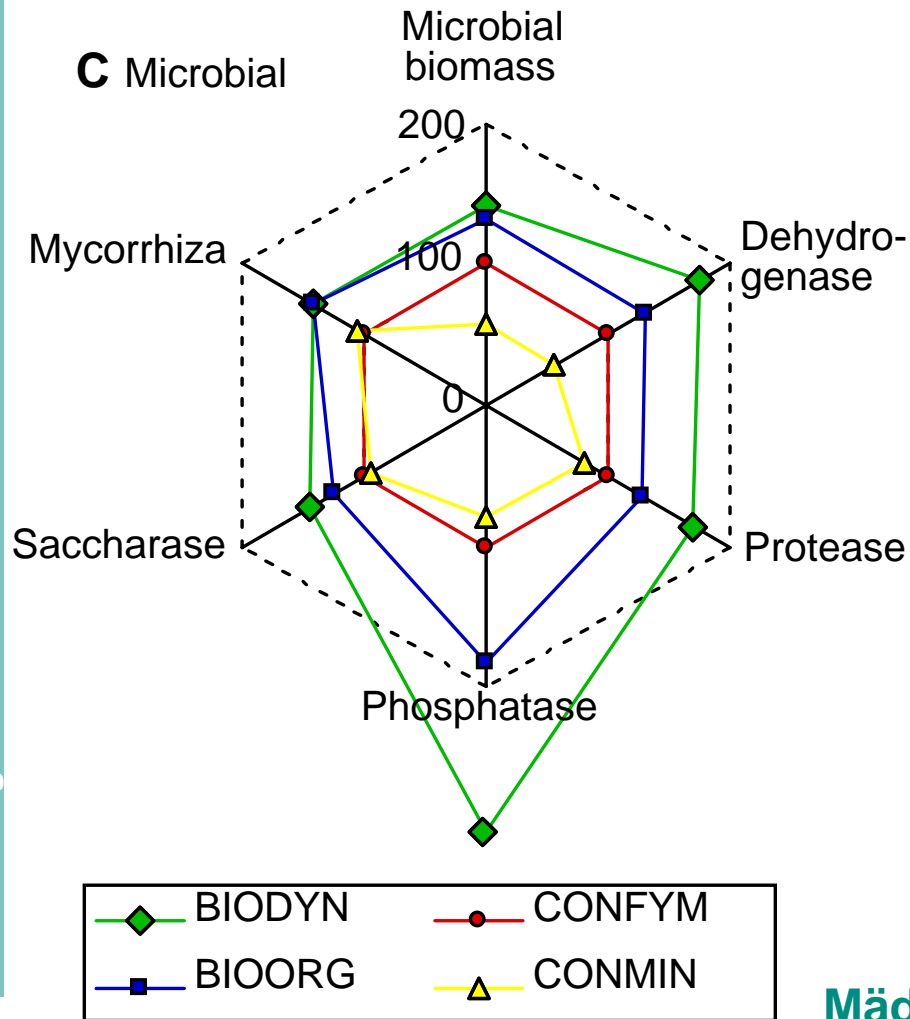
- **Long-term effects of farming systems on soil fertility**
 - Plot scale: The DOK long-term farming systems trial
 - On farm comparison and monitoring of soil fertility

- **Effects of pollutants and external inputs on soil fertility**
 - Heavy metals
 - Pesticide spraying sequences
 - Bio-control bacterium

The DOK long-term system comparison



Soil fertility indicators in the DOK-trial

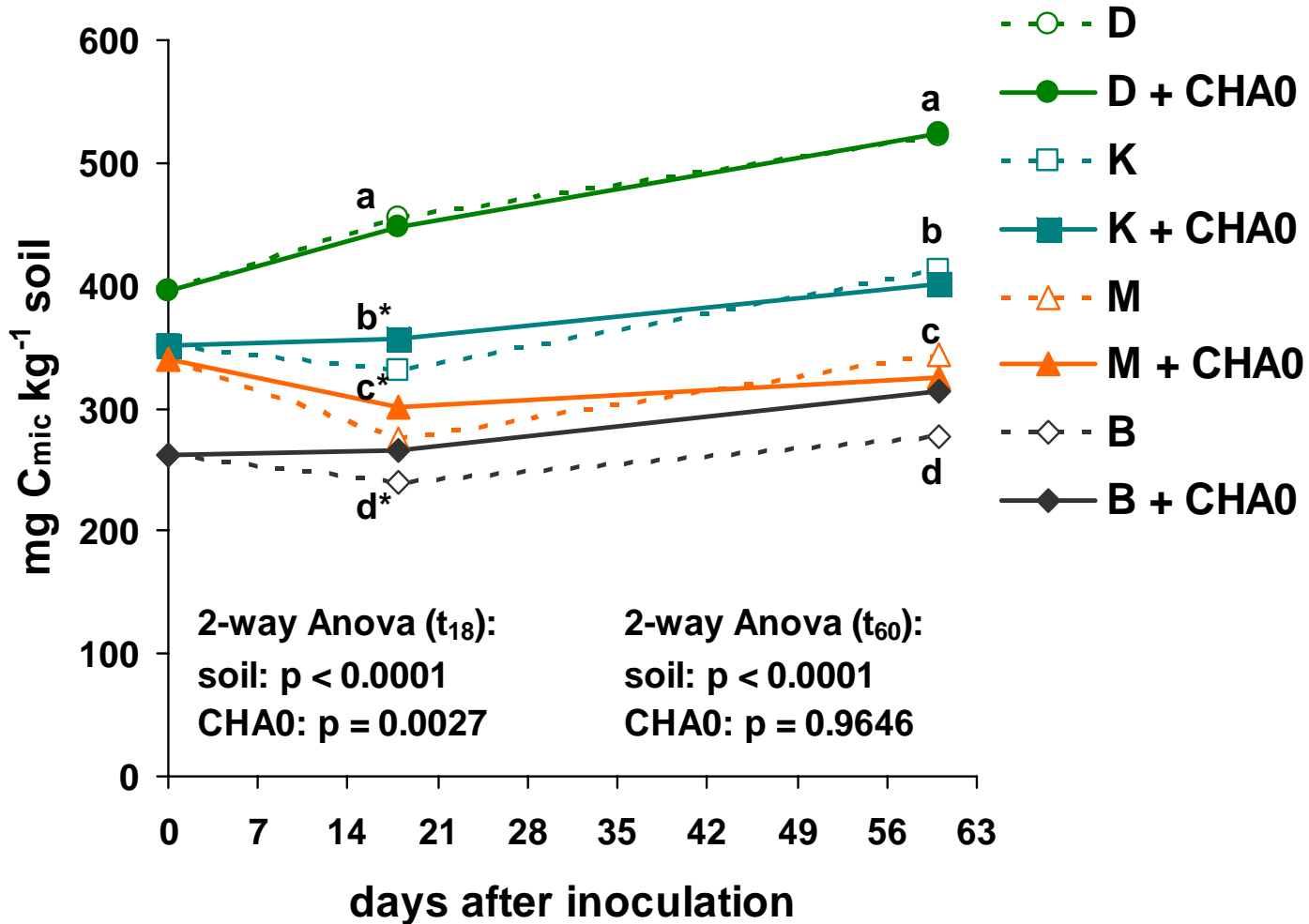


Mäder, Fließbach *et al.*, 2002: *Science* 296

Effects of *P. fluorescens* CHA0 on soil microbial biomass – the pot trial



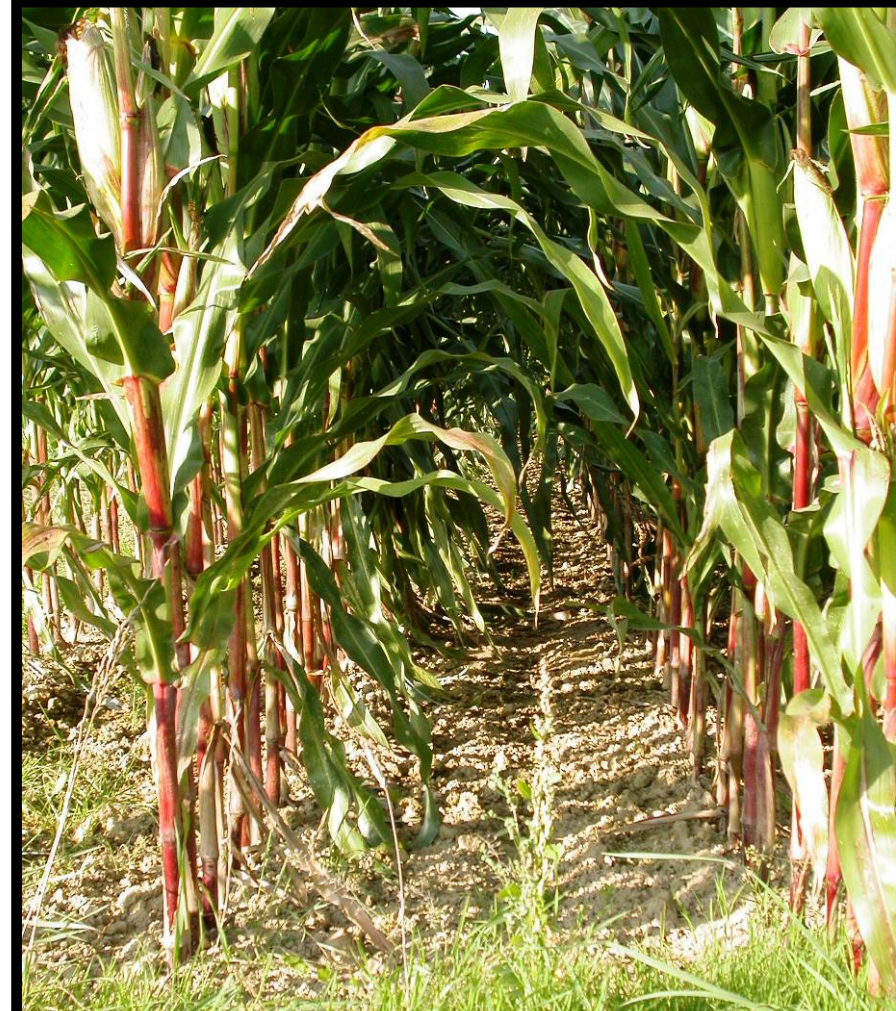
Effects of *P. fluorescens* CHA0 on soil microbial biomass (C_{mic})



Model plant maize (grown in the DOK-trial)



organic



integrated

Objectives

- To review GM-plant effects in soils with different initial soil fertility
- To assess effects of *Bt*-maize and control lines on key microbial indicators of soil fertility
- To investigate the extent and duration of changes depending on the initial soil fertility level
- To assess the time needed for recovery (resilience) after *Bt*-maize cultivation
- To determine the decomposition of *Bt*-maize residues considering plant tissue quality

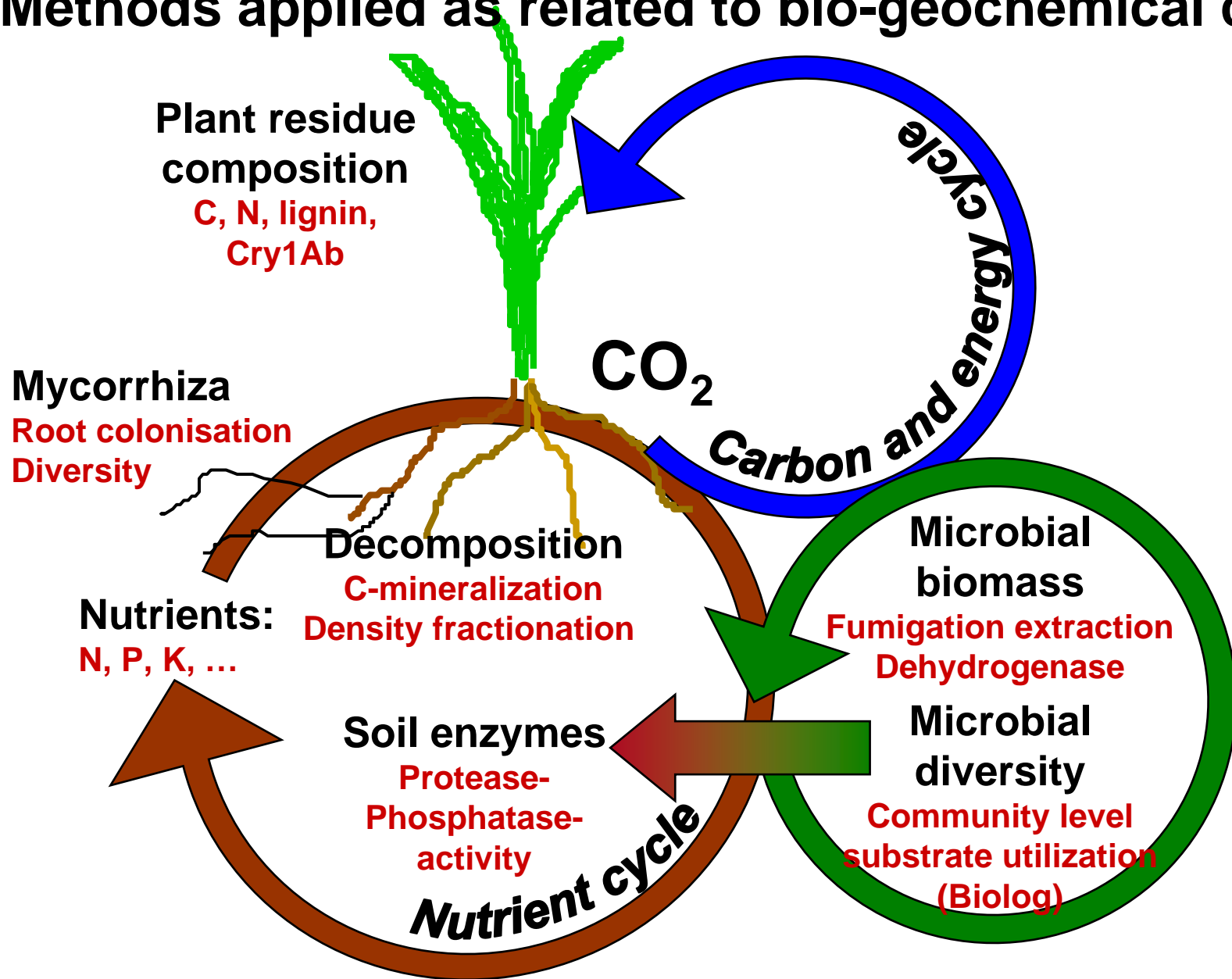
Experimental concept

- **Experimental approach:**
Mesocosms using field soils in climatic growth rooms
- **Model crop:**
 - ***Bt*-maize: transformation event Bt11 (BtCry1Ab protein) controlling corn borer (*Ostrinia nubilalis*)**
 - **Isogenic breeding line: NK4640**
We are grateful to Prof. Geneviève Defago (ETH Zürich) for providing the seeds.
- **Soils:**
Organic and Integrated systems from the 30 year old DOK trial;
plus maize mono-culture system

The mesocosms (here used for potatoes)



Methods applied as related to bio-geochemical cycles



Research steps and time table

	2007		2008				2009				2010	
Research steps	3	4	1	2	3	4	1	2	3	4	1	2
Literature review on the response of soil microbiota to <i>Bt</i> -maize	█											
Short term effects of <i>Bt</i> -maize on soil fertility				█								
Long term effects of <i>Bt</i> -maize on soil fertility								█				
Decomposition of <i>Bt</i> -maize considering plant tissue quality							█					

Links to other projects

Three projects within NRP 59

- **Population dynamics of arbuscular mycorrhizal fungi under transgenic strawberries (Wiemken, Boller, Univ. Basel)**
- **Transgenic strawberries and their wild relatives – a potential model for extinction by hybridization (Erhardt, Univ. Basel)**
- **Adhesion of transgenic Cry proteins to mineral and organic soil surfaces: implications for the fate and bioactivity of transgenic products in the environment (Schwarzenbach, ETH Zürich)**

Two projects in the South

- **Introduction of bio-inoculants in wheat-pulse rotations (ISCB)**
- **System comparison in Madhya Pradesh (Dynamic - Organic – conventional – GM crops; SDC, COOP, Biovision foundation)**

Maize seed germination test



Thank you!

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Additional information

Hypotheses

- The chemical composition of the *Bt*-maize may be different from its isogenic line, which implies that this unintended change generates larger effects than the intended modification to express the *Bt*-protein.
- Soils with high initial microbial activity are more resistant to perturbation caused by the GM-plant, than soils that are low in microbial activity.
- The effects of *Bt*-maize on soil fertility are increasing with the time of *Bt*-maize cultivation.
- The time for recovery of soil microbial indicators is longer in intensively managed soils, that are poor in microbial biomass and activity than in soils with high microbial biomass levels.

Significance of the planned work

➤ Scientific

- Effects of GM-plants on soil organic matter dynamics and bio-geochemical cycles
- Site dependence of GM-plants explained by level of soil fertility
- Development of an improved protocol for GM-plant risk assessment

➤ Social and economic

- GM-plant a risk or a contribution to sustainable agriculture?
- Response of organic and conventional soils to GM-plants may stimulate the debate
- Input reduction due to GM-plants may be economically important, if no further risks are detectable