

# Influence of compost and digestates on plant growth and health: potentials and limits

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## Overview

- Presentation of the research project
- Chemical and biological characteristics of Swiss digestates and composts
- Influence of composts and digestates on plant growth and health
- Influence of composts and digestates on the mineralized nitrogen content of soils
- Application of Swiss digestates and composts in the field
- Conclusions

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## The research project

- Aims: Characterization of the chemical and biological quality of Swiss composts and digestates in order to estimate their potential to positively influence soil fertility and plant health
- Co-ordination with the project “Organic pollutants in Swiss composts and digestates” (Thomas Kupper, EPFL, Presentation in session 1)

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## Materials

- **100 Swiss composts and digestates, representative with respect to**
  - **Origin of the materials (urban / rural)**
  - **Composition of the materials**
  - **Composting systems**
  - **Products (according to ASCP Guidelines 2001)**
    - > Ds=digestate solid
    - > Ca=compost for agriculture
    - > Ch=compost for horticultural use
    - > Cc=compost for covered cultures and private gardening.
  - **Turning techniques**
  - **Turning intensity**
  - **Hygienization**
  - **Forced aeration**
  - **Humidity management**

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## Methods

- › **Nutrients and heavy metals**
  - › According to the official Swiss methods
- › **Influence on nitrogen mineralization in soil**
  - › According to the official Swiss methods
- › **Enzyme activity**
  - › Fluorescein diacetate, dehydrogenase, protease, cellulase
- › **Respirometric activity**
  - › According to Bockreis et al., 2000
- › **Biotests**
  - › Phytotoxicity tests according to Fuchs and Bieri, 2000
  - › Disease suppressivity tests according to Fuchs, 2002

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## Chemical characteristics of Swiss digestates and composts



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## Physical and chemical characteristics of Swiss digestates and composts

- › Values for the different products varied greatly
  - › the contents of salts, nitrogen, phosphorus, potassium, magnesium and calcium depends predominantly on the materials of origin
  - › organic matter and density are mainly influenced by the maturity of the products
  - › high variability was observed for all parameters within a product category
- › Heavy metal contents are low
  - › The great majority of the values are below 50% of the Swiss limits (mg/kg DM: Pb 120, Cd 1, Cu 100, Ni 30, Hg 1, Zn 400)
  - › Copper is the element which exceeded the limits most frequently

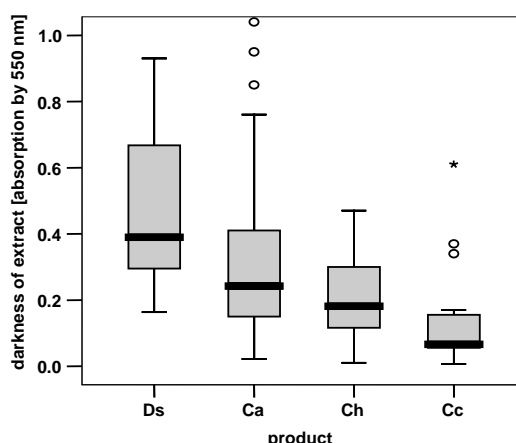
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## Stability of the organic matter

– colour of water extract



Ds=digestate solid, Ca=compost for agriculture, Ch=compost for horticultural use, Cc=compost for covered cultures and private gardening.

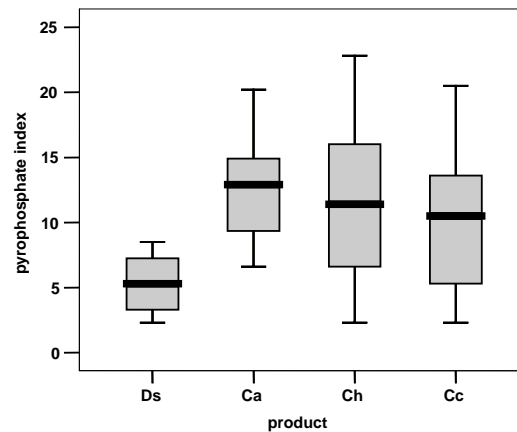
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## Stability of the organic matter

– pyrophosphate index



Ds=digestate solid, Ca=compost for agriculture, Ch=compost for horticultural use,  
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## Stability of the organic matter

### › Water extract

- › The material of origin had some influence on the darkness of the compost extract, but the major influence came from the maturity of the compost

### › Pyrophosphate index

- › The stability of the humus forms, characterized by a low index, has a slow evolution. The variation within a product class is more important than between classes. The influence of the composting materials seems to play a more important role than the maturation process, in view of the considered composting duration.



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## Biological characteristics of Swiss digestates and composts

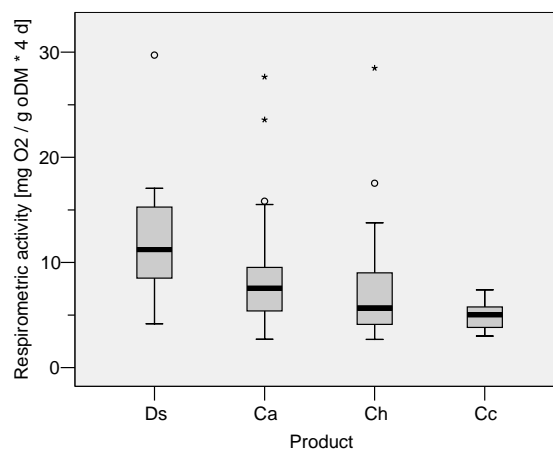


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### Biological activity – respirometric activity

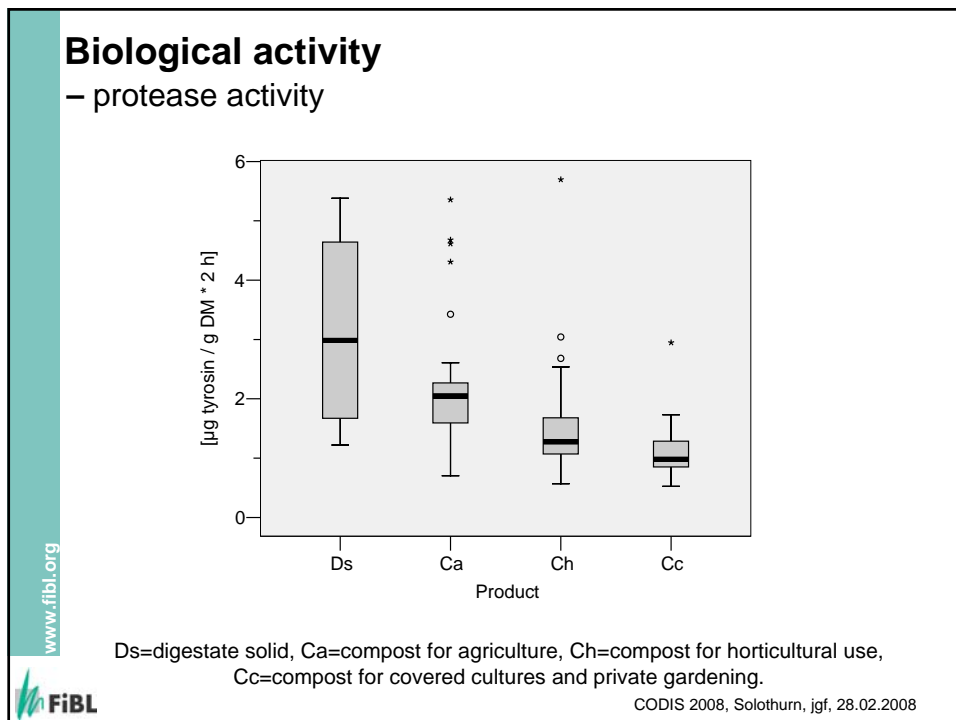
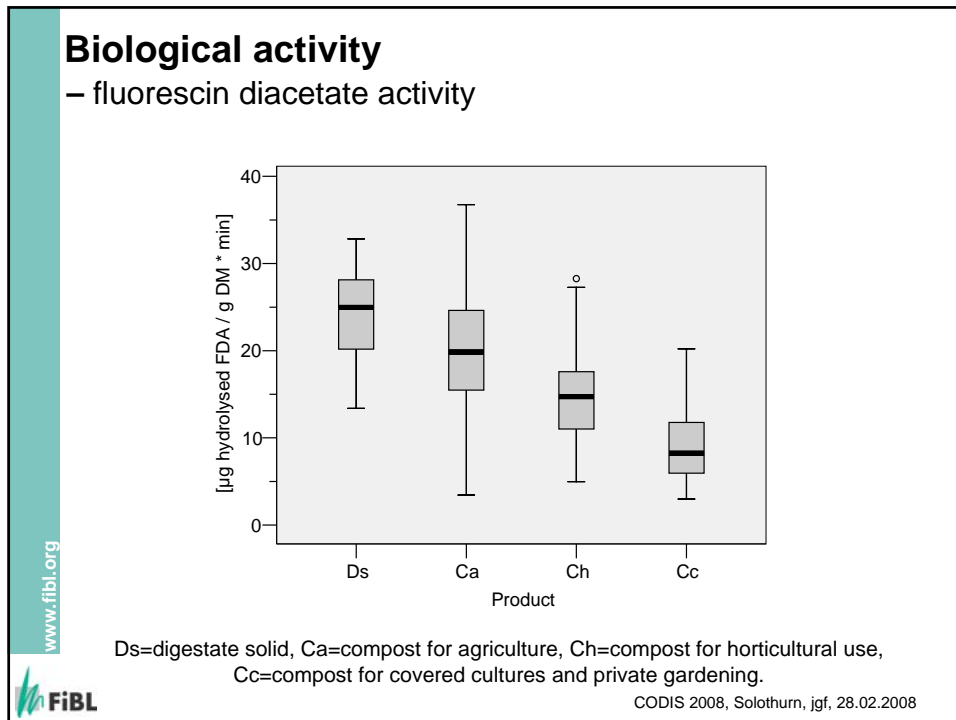


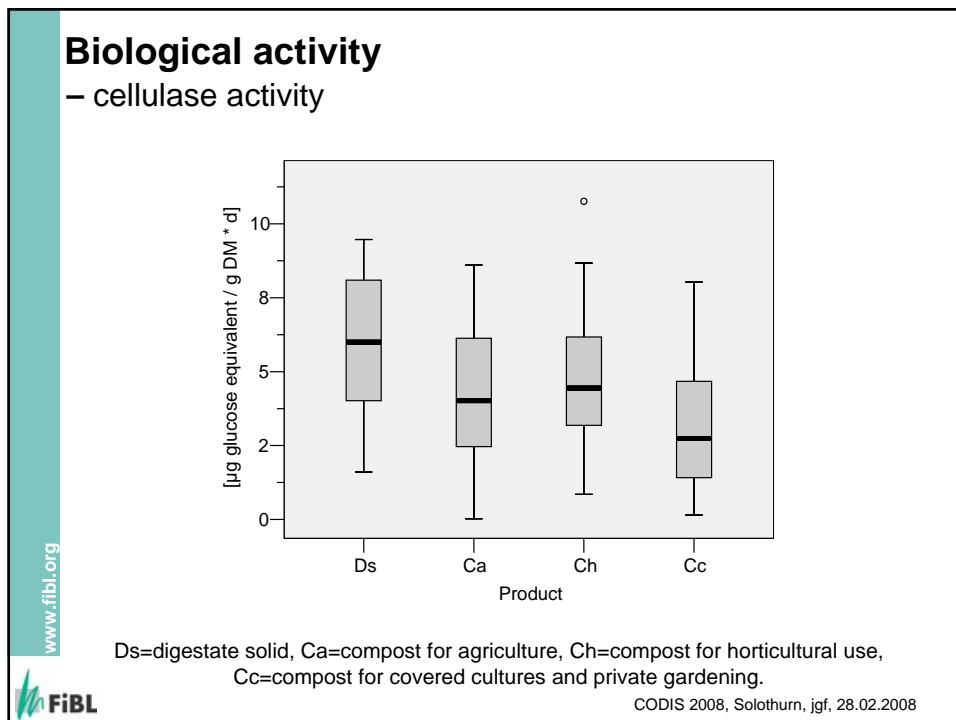
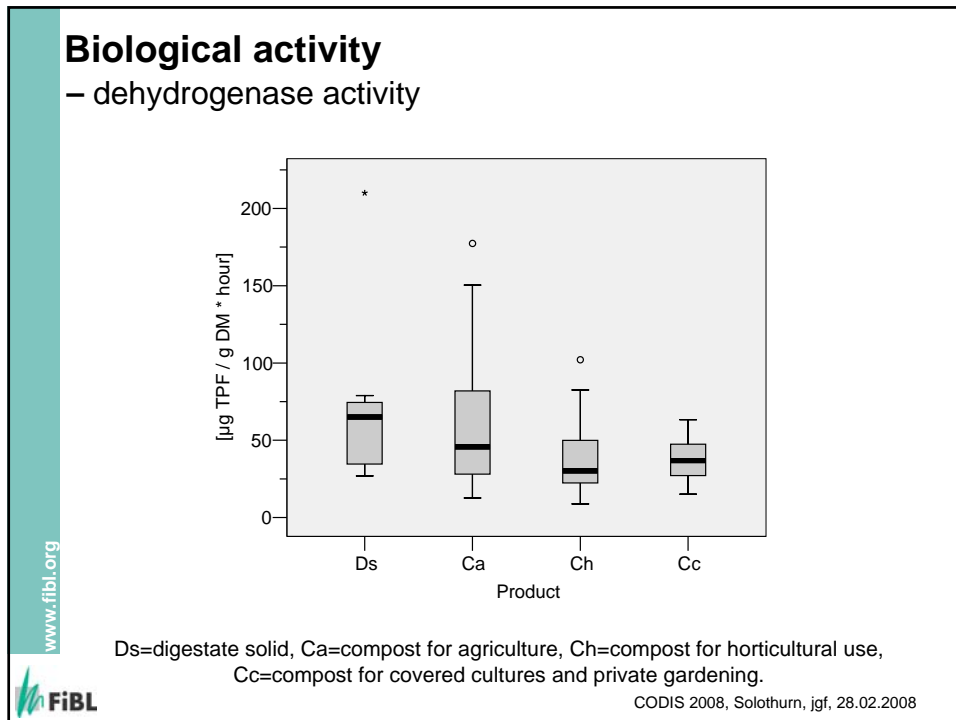
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Ds=digestate solid, Ca=compost for agriculture, Ch=compost for horticultural use,  
Cc=compost for covered cultures and private gardening.

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## Biological activity

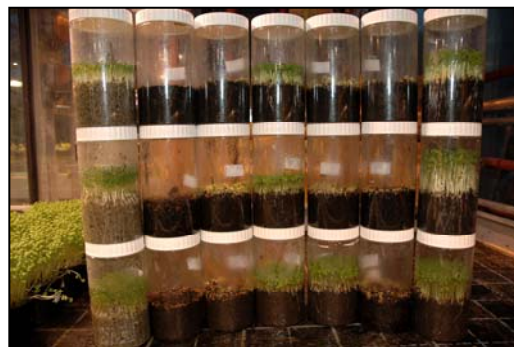
- **Respiration rate**
  - The Respiration rate decreased with compost maturation
  
- **Enzymatic activity**
  - FDA (fluorescein diacetate activity) and protease activity differed significantly between the different product classes.
  - Cellulase activity shows a similar pattern, but less pronounced
  - Dehydrogenase activity was less influenced by the maturity of the products
  
- **The biological activity of digestates is higher than the activity of composts**

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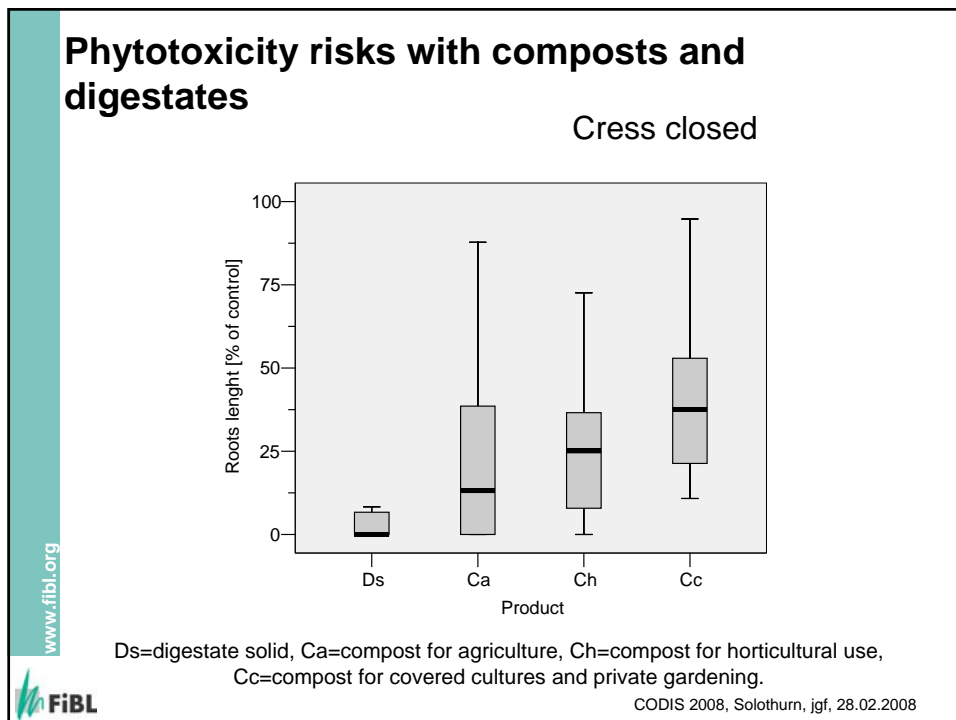
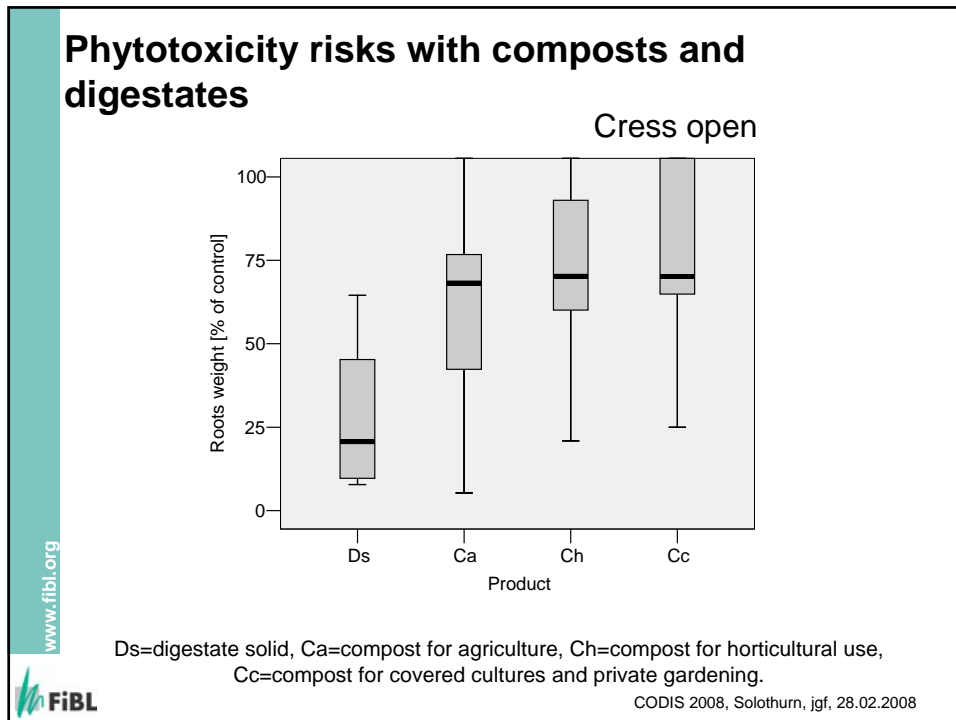
## Influence of composts and digestates on plant growth and health



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## Phytotoxicity risks with composts and digestates

- In all test systems, an evolution of the plant compatibility was observed, with the plants growing better in more mature composts
- Digestates are only partly compatible with plants
- There was considerable variation within a product class
- The management of the composting process seems to be at least as important for the biological quality as the maturation advancement

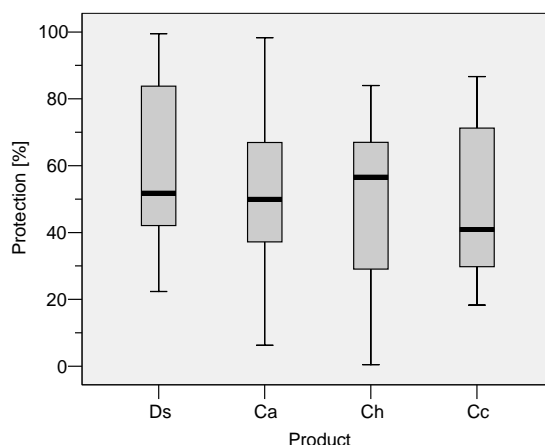
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## Potential for disease suppression

Cucumber – *Pythium ultimum*



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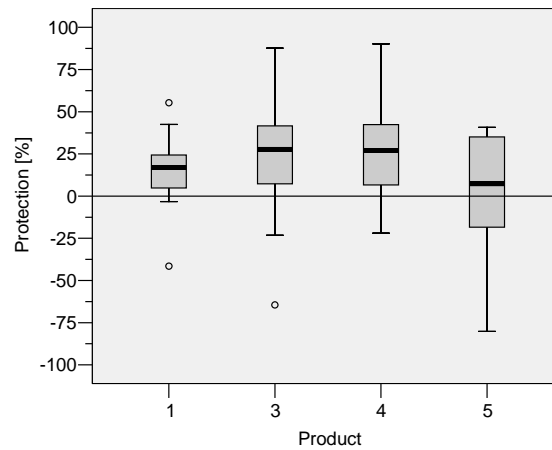


Ds=digestate solid, Dl=digestat liquid, Ca=compost for agriculture, Ch=compost for horticultural use, Cc=compost for covered cultures and private gardening.

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## Potential for disease suppression

Basil – *Rhizoctonia solani*



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## Potential for disease suppression

- The great majority of the composts significantly reduced the incidence of *P. ultimum* on cucumber. There were no differences between products classes.
- The protection of basil against *R. solani* was clearly less efficient. It seems that the capacity of the composts to protect basil against *R. solani* reached a maximum at the stage “Compost for horticulture”.
- The management of the composting process seems to be a major factor influencing the suppressive capacity of the composts.

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## Influence of digestates and composts on the mineralized nitrogen content of soils



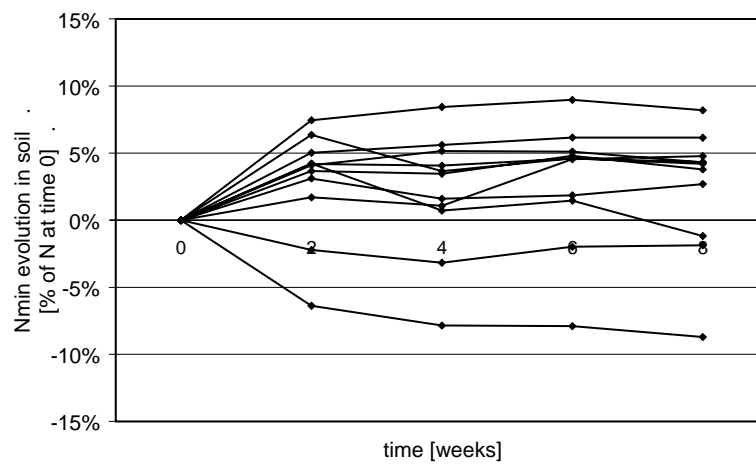
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## Influence of digestates and composts on the mineralized nitrogen content of soils

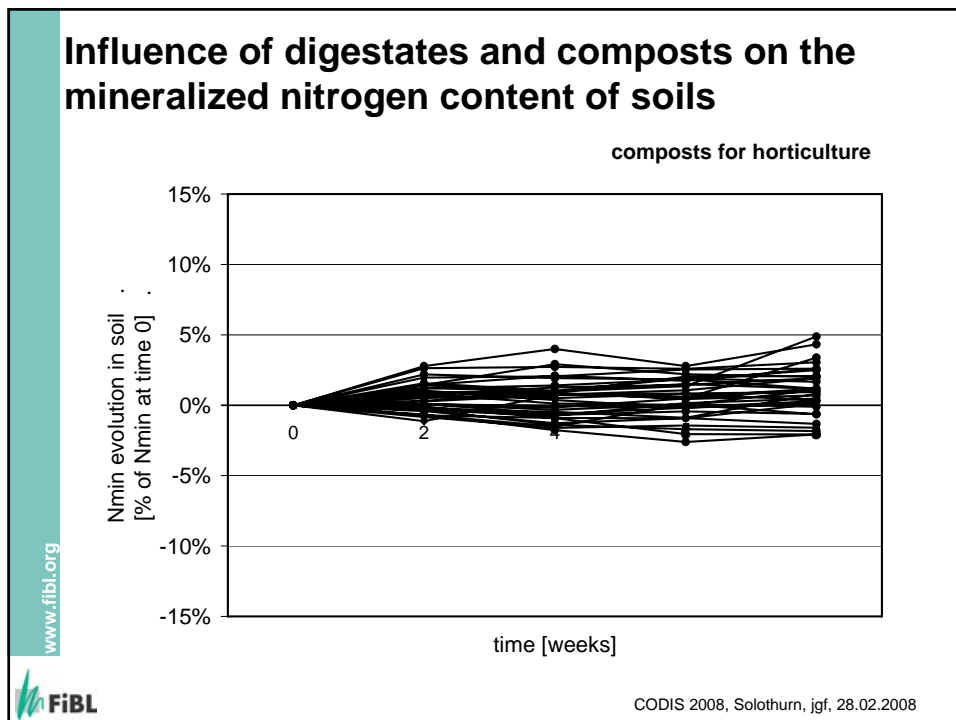
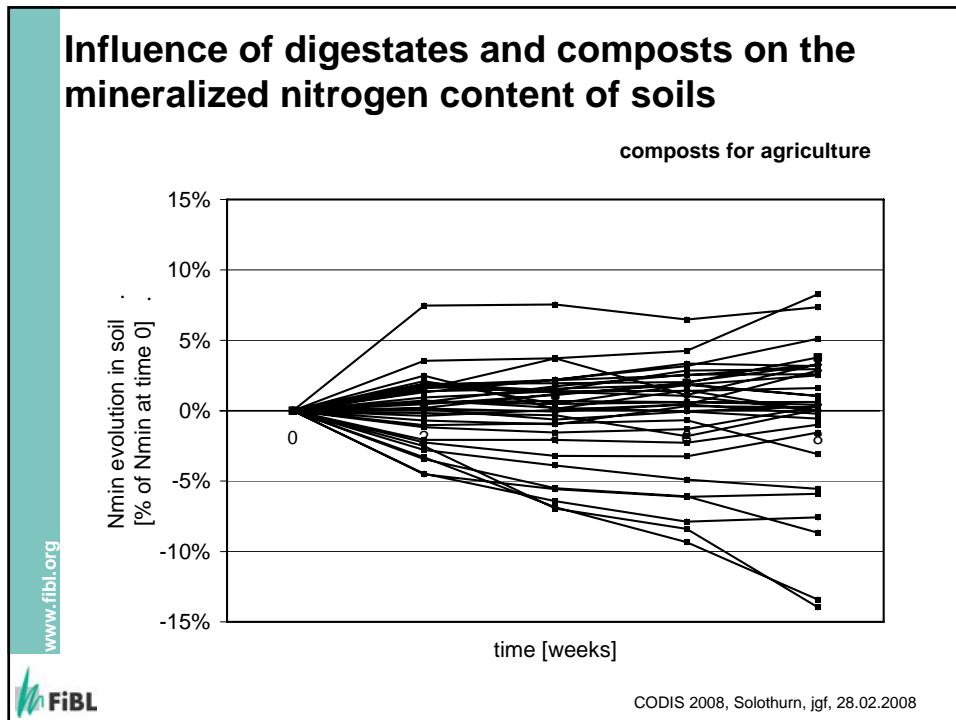
digestate for agriculture



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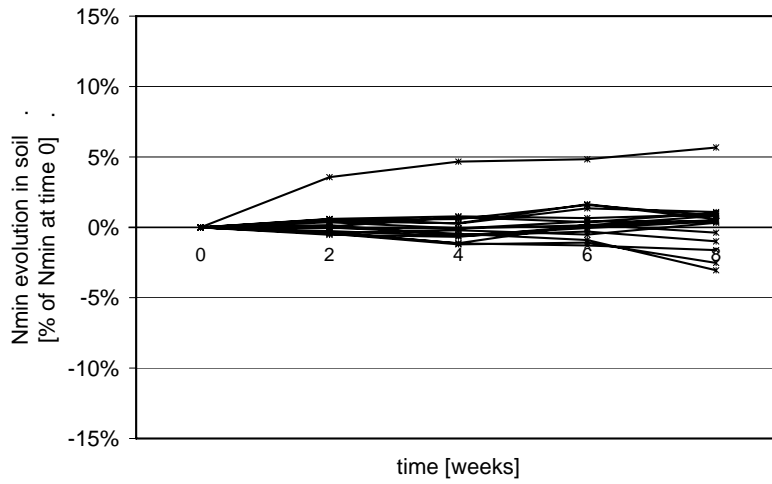


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### Influence of digestates and composts on the mineralized nitrogen content of soils

composts for covered cultures



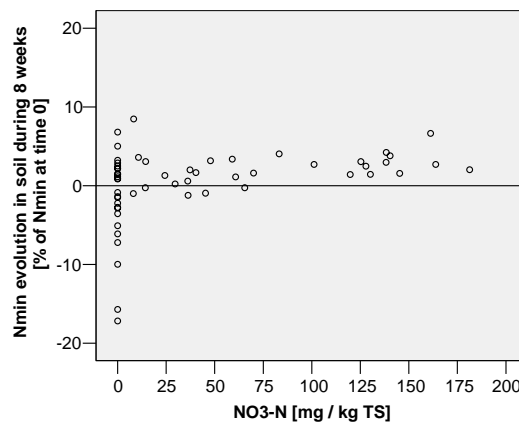
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### Influence of digestates and composts on the mineralized nitrogen content of soils

Evolution of mineralized nitrogen content in soil - nitrate content in compost



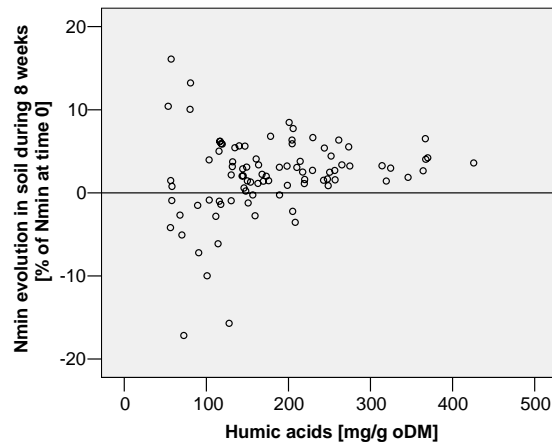
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## Influence of digestates and composts on the mineralized nitrogen content of soils

Evolution of mineralized nitrogen content in soil - humic acids content in compost



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## Influence of digestates and composts on the mineralized nitrogen content of soils

- Immobilization of nitrogen in soil by some digestates by inadequate subsequent treatment, during which the digestate has been dry .
- The composts for agricultural use are mainly young composts rich in undegraded lignin. The degradation of these woody substances in soil leads to a momentary immobilization of the available nitrogen. When the composts were more mature, this risk decreased.
- Two compost parameters allowed to predict the risk of nitrogen immobilization with compost: the nitrate and the humic acids contents.

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## Digestates and composts in the field



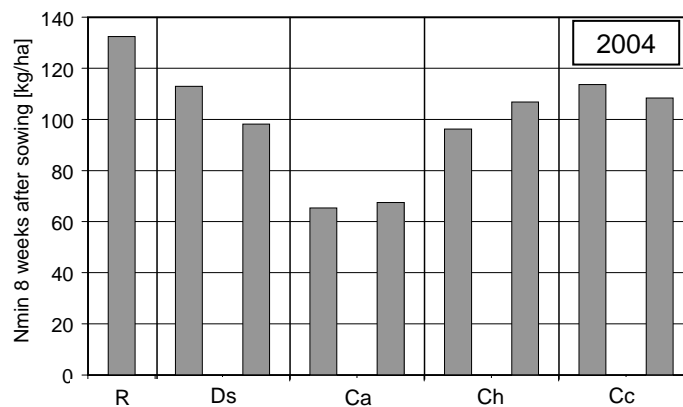
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## Digestates and composts in the field

### > Influence on Nmin in soil

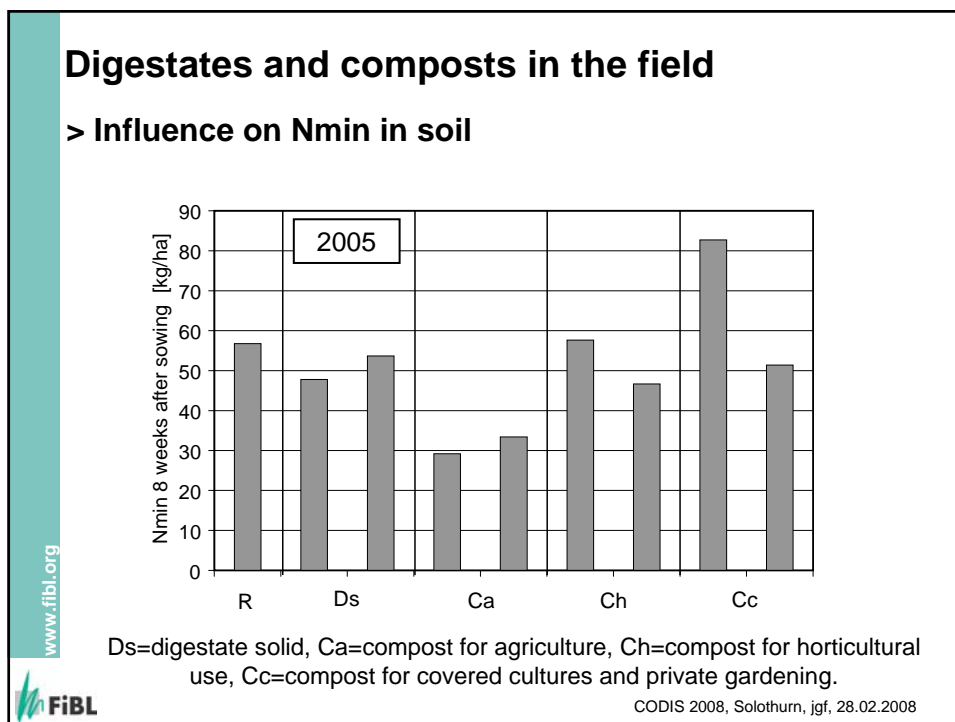
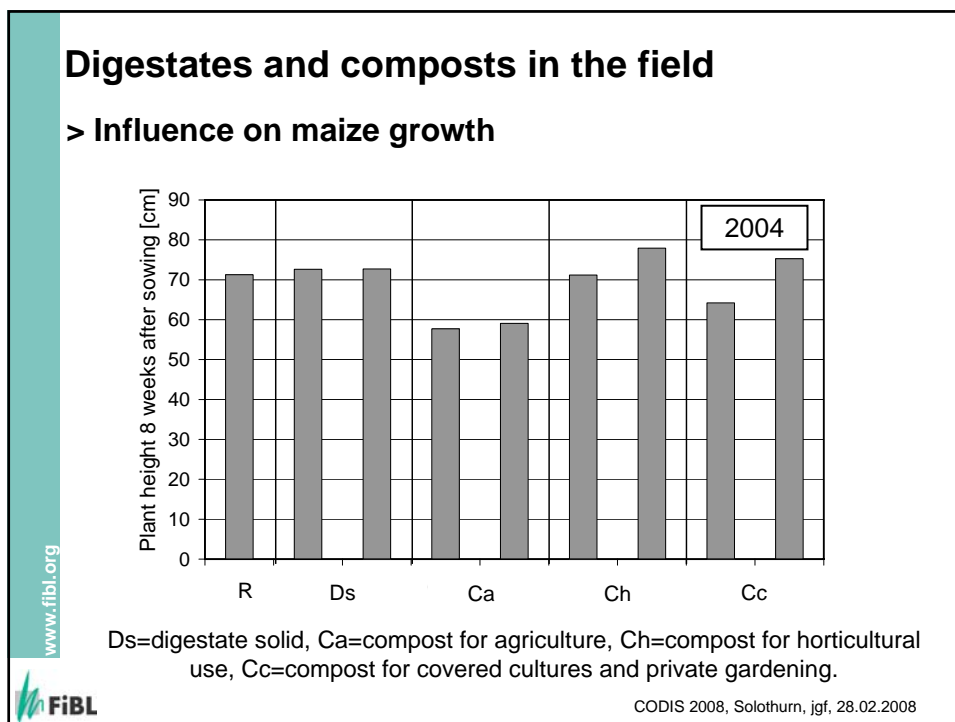


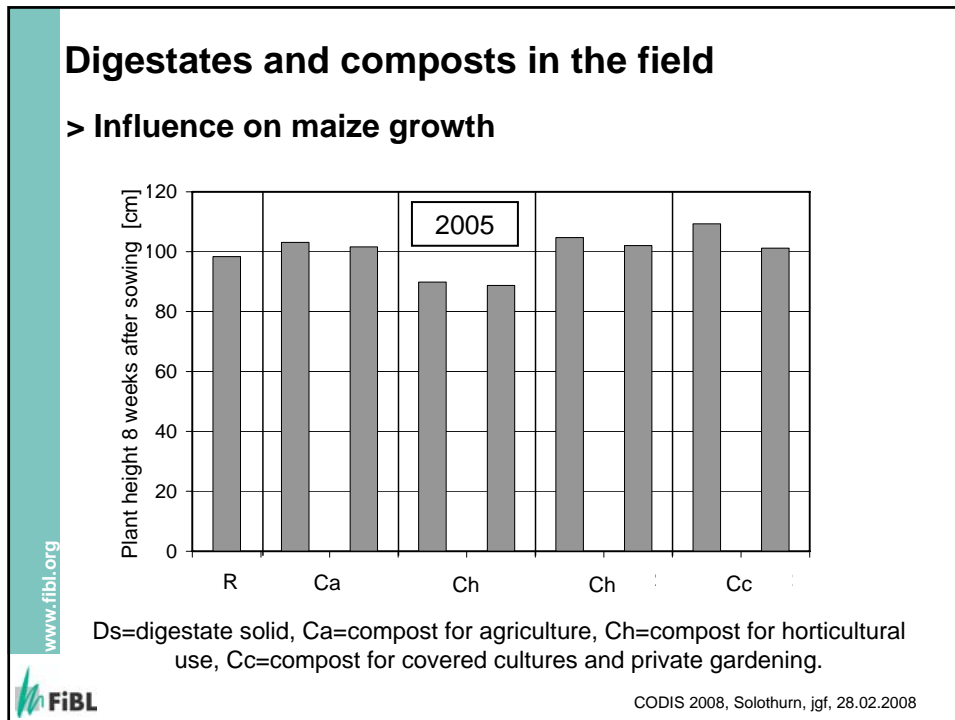
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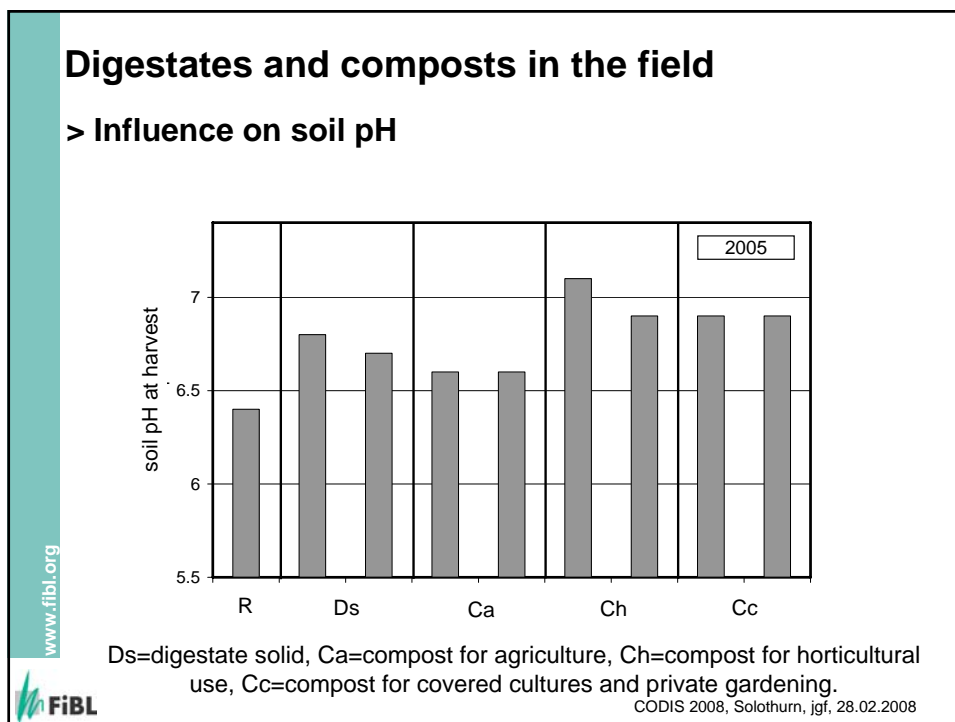
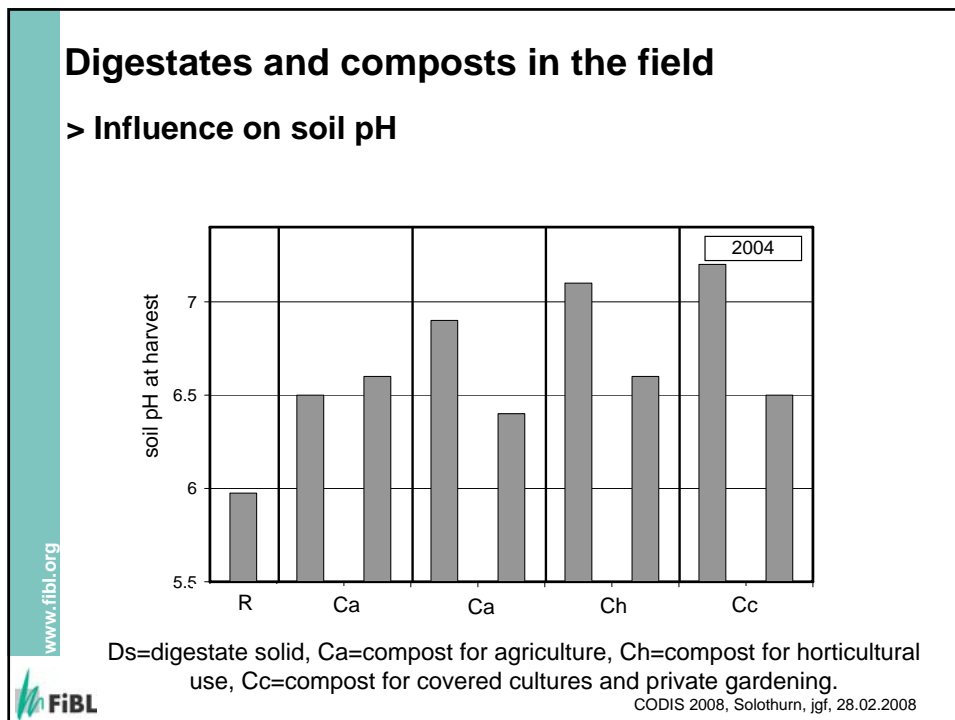


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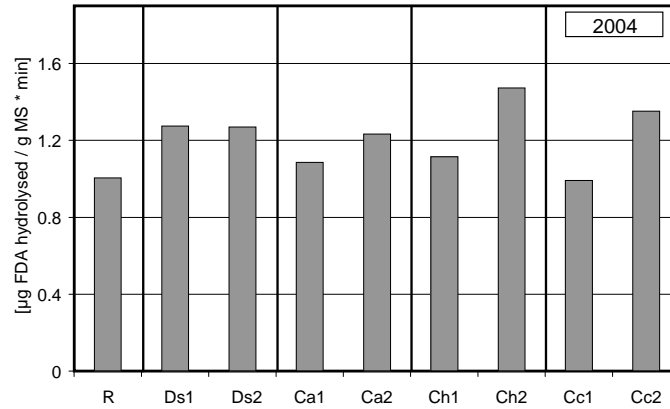


- ### Digestates and composts in the field
- The four composts for agriculture tested immobilized nitrogen in soil and had a negative influence on maize growth at the beginning of the culture.
  - These results confirm the results obtained in the laboratory: compost with almost no  $\text{NO}_3\text{-N}$  Nmin and with humic acids contents lower than 130 [mg / g oDM] immobilized nitrogen also in the field (true only for composts, not for digestates).
  - Nitrogen fertilization after 8 weeks allows correcting the nitrogen deficiency.
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### Digestates and composts in the field

> Influence on soil properties:  
biological activity of soil at harvest



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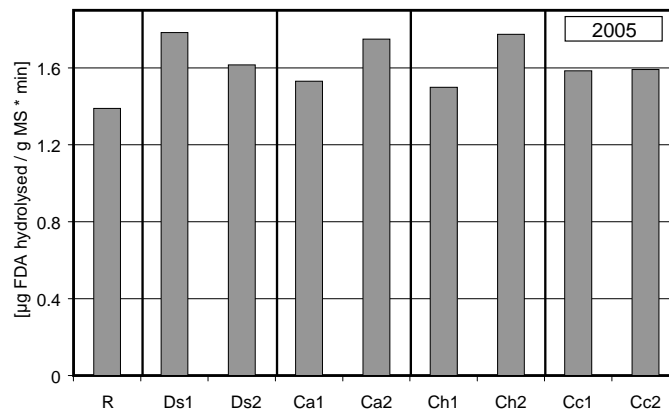
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### Digestates and composts in the field

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## Digestates and composts in the field

- > **Choice of the correct product (to avoid N-immobilisation)**
- > **Strong influence on soil pH (for digestates and for composts: (+0,5 – 1 pH-unit). Long-term effect ?**
- > **After 1 season: increase of biological activity of soil, but almost no influence on its disease receptivity (too short experimental period ? too good soil ?)**

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## Conclusions 1

- > **In general, the quality of the Swiss composts is good**
- > **Nevertheless, the characteristics of the different digestates and composts vary in an important way**
- > **Some parameters are influenced principally by the materials of origin, other parameters are principally influenced by the maturity of the products and the process management**
- > **The choice of the right compost for the envisaged utilization is very important**

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## Conclusions 2

- > Attention should be given to nitrogen immobilization, particularly when compost is used in spring
- > The nitrate and the humic acids contents of the compost can help to predict the risk of N-immobilization in the soil.
- > In the field experiment, the digestates and composts showed very interesting effects on the soil pH and on the microbiological soil activity

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## Acknowledgements

The authors thank

- > the Swiss Federal Office for the Environment FOEN,
- > the Swiss Federal Office of Energy SFOE,
- > the Federal Office for Agriculture FOAG,
- > the canton Zürich (CH),
- > the Association of Swiss Compost and Methanisation Plants ASCP, and
- > the Swiss compost and digestate producers

for financial and/or technical support.

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