Presentation at the International Symposium

Organic Matter Management & Using Compost in Horticulture

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Research Institute of Organic Agriculture
Forschungsinstitut für biologischen Landbau
Institut de recherche de l'agriculture biologique

Effects of compost on soil fertility parameters in mid- and long-term experiments

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Effects of compost on soil fertility parameters in mid- and long-term experiments

- Introduction
- Application of Swiss digestates and composts in maize fields
- KOB-trial: fertilization of organic apple orchard with compost and organic fertilizers
- DOK long-term field trial
- Conclusions

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Introduction

- Composts and digestates influence soil fertility and plant growth, such as:
  - Supply of nutrients (macro- and oligo-elements)
  - Supply of more or less stabilized organic matter
  - Influence on soil-pH
  - Improvement of soil structure
  - Reduction of erosion
  - Improvement of water capacity
  - Improvement of soil aeration
  - Influence of biological activity
  - Supply of microorganisms

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Introduction

- **The influence of composts and digestates on soil fertility and plant growth can vary depending on:**
  - **Quality of compost and digestate**
    - **Composition of starting materials**
    - **Process management**
    - **Maturity of the products**
    - **Storage management of the products**
  - **Strategy and techniques of product application**
  - **Target culture**
  - **Type of soil**
  - **Climatic conditions**

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Introduction

- **Aim of the presented projects:**
- Evaluation of the medium- and long-term influences of compost and digestate on soil fertility and plant growth in various crops

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Application of Swiss digestates and composts in maize fields

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Application of Swiss digestates and composts in maize fields

- Two field experiments: one in loamy soil, one in sandy soil
- Application of eight Swiss digestates and composts (control: mineral fertilizer)
- Compost application in spring (100 m^3/ha), soil samples taken in autumn after harvest
- Analyses of nutrient contents, pH and nitrogen mineralization according to official Swiss methods
- Analyses of enzyme activities according to Inbar et al. (1991) and Alef and Nannipieri (1995)

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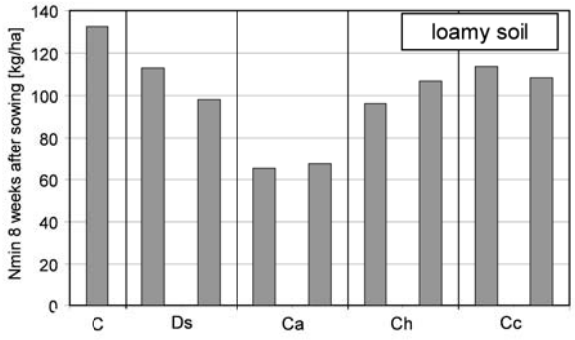
Application of Swiss digestates and composts in maize fields on loamy soil

- Influence on N_{min} in soil



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

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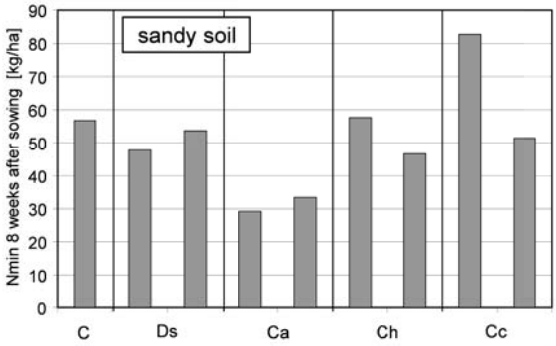
Application of Swiss digestates and composts in maize fields on sandy soil

- Influence on N_{min} in soil



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Application of Swiss digestates and composts in maize fields

- Influence on N_{min} in soil
  - The four 'composts for agriculture' immobilized nitrogen in the 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 NO_3-N and with less than 130 [mg/g oDM] humic acids immobilized nitrogen also in the field (true only for composts, not for digestates). SB1
  - Nitrogen fertilization after 8 weeks allows correcting the nitrogen deficiency.

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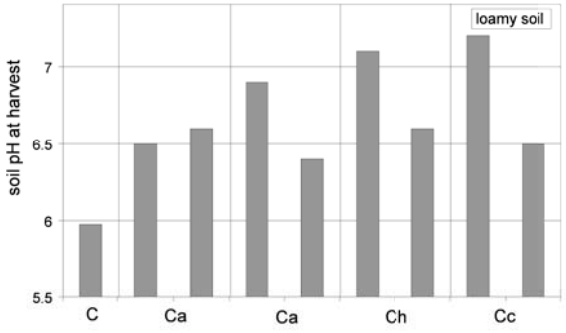
Application of Swiss digestates and composts in maize fields

- Influence on soil pH



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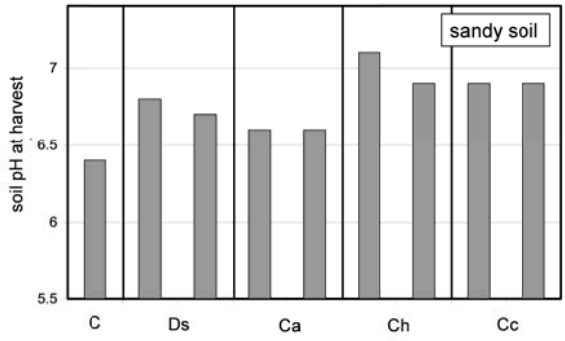
Application of Swiss digestates and composts in maize fields

- Influence on soil pH



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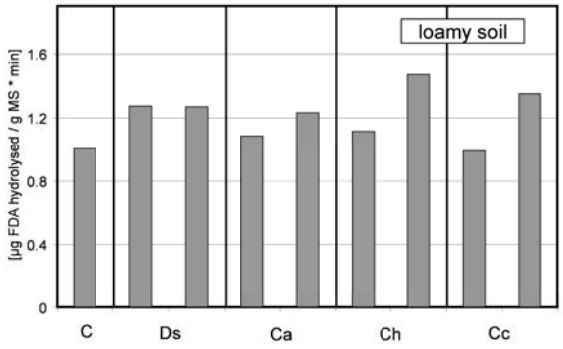
Application of Swiss digestates and composts in maize fields

› **Influence on soil biological activity at harvest**



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Application of Swiss digestates and composts in maize fields

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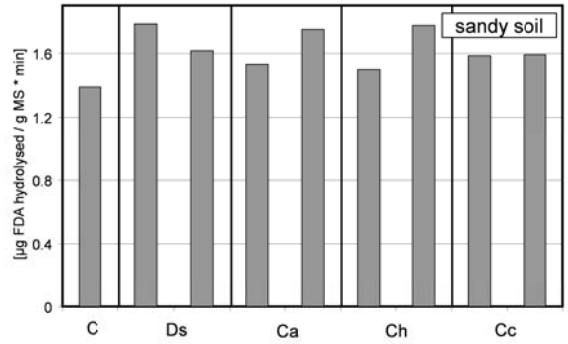

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Application of Swiss digestates and composts in maize fields

› **Conclusions**

- **Importance of the choice of the correct product (e.g. 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** (data not shown)**: too short experimental period ? too good soil ?**

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KOB-trial: fertilization of an organic apple orchard with compost and organic fertilizers SB1

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KOB-trial: fertilization of an organic apple orchard with compost and organic fertilizers

- Full factorial experiment in a commercial organic orchard in Switzerland (regularly, but almost too weekly growing apple trees, cv. Topaz, grafted on the very weekly growing rootstock M27)
- Soil: alluvial para-brown soil of silty clay with signs of pseudo-gley. Soil pH ($CaCl_2$): 5.4-6; content of organic matter in the 0-25 cm layer: 3.0.
- Compost (5 m^3 ha^{-1} yr^{-1}), commercial N-fertilizer and foliar N-fertilizer in 9 different main combinations and 2 sub-treatments

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KOB-trial: fertilization of an organic apple orchard with compost and organic fertilizers

- Influence on N_{min} in soil
  - The highest N_{min} contents in soil could be found in Mai
  - The highest N_{min} content was found in the plots with organic N-fertilizer without compost
  - The plots with compost without organic fertilizer had an intermediate N_{min} content, while the plots with compost and organic fertilizer had the lowest N_{min} content
  - At the sampling date in July, the average N_{min} contents were already much lower. No difference was observed between the different treatments

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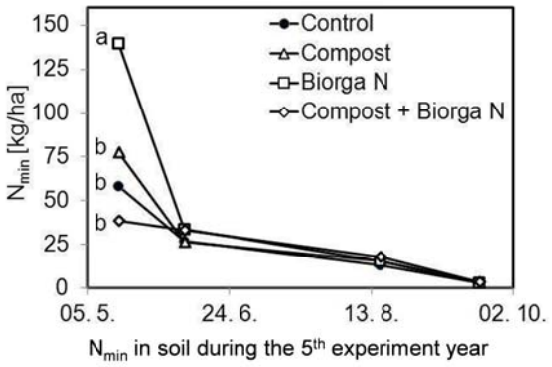
KOB-trial: fertilization of an organic apple orchard with compost and organic fertilizers

› **Influence on N_{min} in soil**



N_{min} in soil during the 5th experiment year

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KOB-trial: fertilization of an organic apple orchard with compost and organic fertilizers

› **General results**

- › **Long-term effects of the treatments on**
  - › **tree performance (growth, yield, specific yield)**
  - › **fruit quality**
  - › **mineral concentration in leaves and fruit**
  - › **soil fertility parameters (organic carbon content, enzymatic activities, soil aggregate distribution and stability)**

were in most cases of minor importance

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KOB-trial: fertilization of an organic apple orchard with compost and organic fertilizers

› **Conclusions**

- › **The low effect of compost on yield and soil fertility can have several reasons**
  - › **due to its low nitrate content, the compost apparently blocked some of the N_{min} that was mineralized from the soil reserves or came from the N-fertilizer**
  - › **in order to respect the Swiss recommendations and regulations, the applied compost quantities had to be kept very low (only 7-8% of the total C-import of the orchard)**
  - › **soil improvements with such low doses of bio-waste compost seem to require more than 4 years before they improve soil quality and tree performance.**
- › **Possibility to improve compost efficiency by the use of a specific compost ('design compost') ?**

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DOK long-term field trial

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DOK long-term field trial

- Since 1978, four agricultural farming systems are compared
  - CONFYM: mineral and organic fertilizers (manure and slurry), synthetic pesticides
  - BIOORG: organic fertilizers (sligthly composted manure and slurry), mechanical weeding and biological disease and pest control
  - BIODYN: composted manure and bio-dynamic preparations
  - CONMIN: mineral fertilisers only, synthetic pesticides
- fertilization level: 1.2 to 1.4 livestock units ha^{-1} (corresponding to approx. 15-20 m^3 compost ha^{-1} yr^{-1})
- Soil: haplic luvisol on deep alluvial loess

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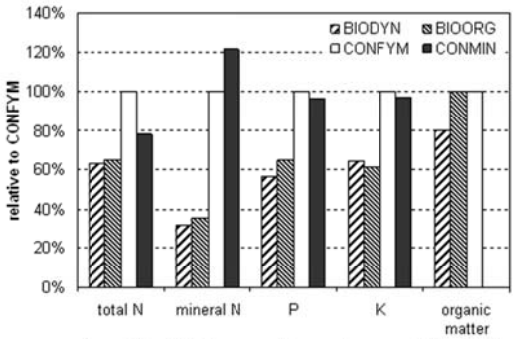
DOK long-term field trial

- Mean relative input of nutrients to the farming systems in the DOK trial (relative to CONFYM)



Input N, P, K in organic systems: - 35 to 40%
Input N_{min} in organic systems: -65 to 70%

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DOK long-term field trial

- Influence on yields
  - Mean yields of all crops per rotation in the organic systems were 80% of those in the conventional systems
  - Fertilizer input (total N, P, K) was reduced by 35 to 40% and nitrogen input in mineral form was even reduced by 65 to 70% in the organic systems
  - The organic farming systems used 20 – 56% less energy to produce a crop unit (36 – 53% per land area)
- The more efficient production of organic systems, based on compost fertilisation, is due to higher soil fertility

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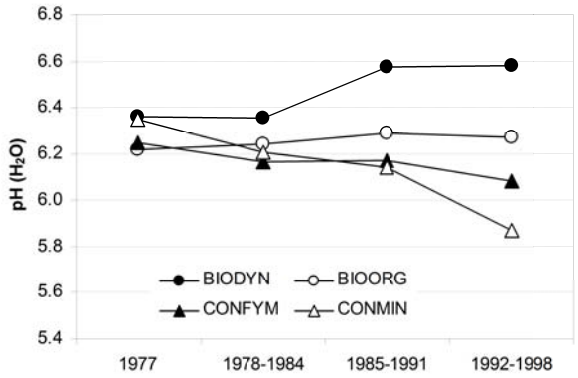
DOK long-term field trial

- Influence on soil pH



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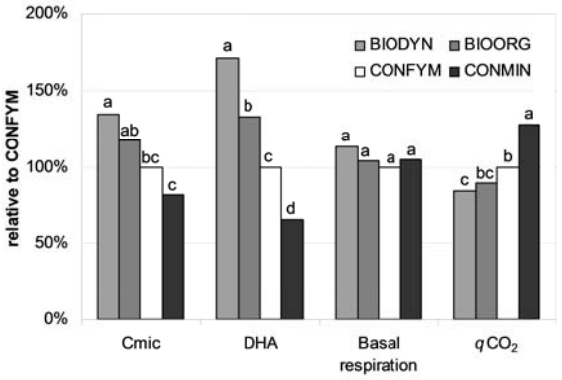
DOK long-term field trial

- Influence on soil microbiological parameters



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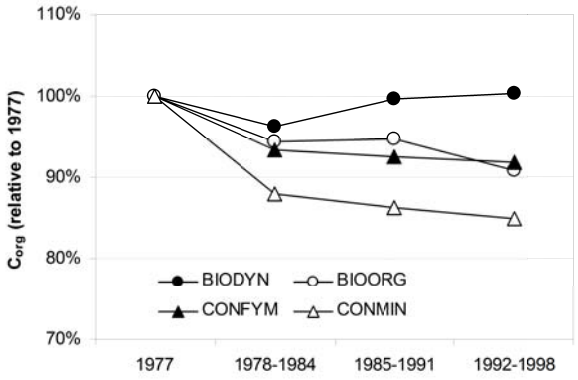
DOK long-term field trial

› Influence on soil C_{org} content



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DOK long-term field trial

› Conclusions
- The organic farming systems, based on compost fertilization, use less energy to produce a crop unit
- Soil pH remained unchanged or increased slightly with the compost amendment, while it diminished with farmyard manure or mineral fertilization
- The biological activity of the soil is enhanced in the treatments with compost
- The higher efficiency of the soil BIODYN in comparison with BIOORG is probably due to the compost quality (more mature)

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Effects of compost on soil fertility parameters in mid- and long-term experiments

› General conclusions (1)
- Digestate and compost can considerably improve soil fertility
- They can influence physical, chemical and biological soil parameters
- The influence of compost and digestate can vary depending on
  - their quality
  - the soil parameters
  - the utilization strategy
  - the target crop

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Effects of compost on soil fertility parameters in mid- and long-term experiments

- **General conclusions (2)**
  - **Especially in crops with legally limited compost quantities, attention has to be given to compost quality and activity, and to the application strategy**
  - **In agricultural use with application of higher compost quantities, the quality of the compost is also very important, to avoid phytotoxicity and nitrogen immobilization**
  - **quality compost is very important to support soil fertility in organic agriculture, especially on stockless farms.**

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Effects of compost on soil fertility parameters in mid- and long-term experiments

- **Acknowledgements**
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Thank you very much for your attention …

… any questions ?

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