Presentation at the International Symposium

Organic Matter Management & Using Compost in Horticulture

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

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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

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
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

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

Application of Swiss digestates and composts in maize fields
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 m³/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)

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

- Influence on Nₘᵢₙ in soil

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

- Influence on Nₘᵢₙ in soil
Application of Swiss digestates and composts in maize fields

- **Influence on \( N_{\text{min}} \) 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 \( \text{NO}_2\)-N and with less than 130 [mg/g dry matter] humic acids immobilized nitrogen also in the field (true only for composts, not for digestates).
  
  - Nitrogen fertilization after 8 weeks allows correcting the nitrogen deficiency.

![Bar chart showing soil pH](chart1.png)

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

Application of Swiss digestates and composts in maize fields

- **Influence on soil pH**

![Bar chart showing soil pH](chart2.png)

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

Application of Swiss digestates and composts in maize fields

- **Influence on soil pH**

![Bar chart showing soil pH](chart3.png)

C=control, Ds=digestate solid, Ca=compost for agriculture, Ch=compost for horticultural use, Cc=compost for covered cultures and private gardening.
Application of Swiss digestates and composts in maize fields

- Influence on soil biological activity at harvest

<table>
<thead>
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<th></th>
<th>C</th>
<th>Ds</th>
<th>Ca</th>
<th>Ch</th>
<th>Cc</th>
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<tbody>
<tr>
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<td>1.2</td>
<td>0.8</td>
<td>1.3</td>
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C=control, Ds=digestate solid, Ca=compost for agriculture, Ch=compost for horticultural use, Cc=compost for covered cultures and private gardening.

Application of Swiss digestates and composts in maize fields

- Influence on soil biological activity at harvest

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<tr>
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<td>0.6</td>
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C=control, Ds=digestate solid, Ca=compost for agriculture, Ch=compost for horticultural use, Cc=compost for covered cultures and private gardening.

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?
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

Influence on $N_{\text{min}}$ in soil

- The highest $N_{\text{min}}$ contents in soil could be found in May.
- The highest $N_{\text{min}}$ content was found in the plots with organic N-fertilizer without compost.
- The plots with compost without organic fertilizer had an intermediate $N_{\text{min}}$ content, while the plots with compost and organic fertilizer had the lowest $N_{\text{min}}$ content.
- At the sampling date in July, the average $N_{\text{min}}$ contents were already much lower. No difference was observed between the different treatments.
KOB-trial: fertilization of an organic apple orchard with compost and organic fertilizers

- Influence on $N_{\text{min}}$ in soil

![Graph showing influence on $N_{\text{min}}$ in soil over time]

- 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

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 $N_{\text{min}}$ that was mineralized from the soil reserves or comes 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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Effects of compost on soil fertility parameters in mid- and long-term experiments

DOK long-term field trial

- Since 1378, four agricultural farming systems are compared
  - CONFYM: mineral and organic fertilizers (manure and slurry), synthetic pesticides
  - BIOORG: organic fertilizers (slightly 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

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\(_{\text{man}}\) in organic systems: 65 to 70%
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.

DOK long-term field trial

- Influence on soil pH

DOK long-term field trial

- Influence on soil microbiological parameters
DOK long-term field trial

- Influence on soil $C_{org}$ content

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)

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
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.

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

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  - For financial support:
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Thank you very much for your attention ...

... any questions?