Introduction

› Biowaste compost production
  › Often payment for taking over the green waste covers nearly the production costs (for minimal quality compost)
  › Costs for production of higher quality have to be covered with the sale of the compost

› Composting / biogas production / burning
  › Competition for input materials between composting and biogas production increases continuously

› Motivations for composting
  › Disposal of green waste?
  › Soil fertility improvement?

Introduction

› Compost user
  › Some users (among others horticultural producers) are convinced of the advantages of compost. They use compost to improve the fertility of their soils and to support the production of their plants.
  › Other users still consider compost as a waste product and are not willing to pay for it.
  › Compost producers have to work on the relationship with these users, to convince them of the positive effects of compost on soil and plants.

Introduction

› Quality management: the solution to assure the future of composting
  › Only good compost are products which can stimulate the interest of the plant growers
  › Qualitative good products alone is not enough to secure the compost market. Communication with the different potential users of compost is very important. To convince him from the advantage of the compost, different actions can be undertaken:
    › Demonstration trials
    › Meetings
    › Visit of trials fields,
    › …
  › As first, a clear quality management concept is needed!
Compost quality and influence on soils and plants

09.11.2012, Tartu (Estonia)

Compost quality management: Swiss concept

- Minimum quality requirements: Swiss legislation
  - FAC guidelines 1995
  - Heavy metals, impurities, hygienisation: ORRChim

- Swiss Legislation: heavy metals

<table>
<thead>
<tr>
<th>Element</th>
<th>Limit (g/t DM)</th>
<th>Limit organic production (g/t DM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>lead (Pb)</td>
<td>120</td>
<td>40</td>
</tr>
<tr>
<td>cadmium (Cd)</td>
<td>1</td>
<td>0.7</td>
</tr>
<tr>
<td>copper (Cu)</td>
<td>100</td>
<td>70</td>
</tr>
<tr>
<td>nickel (Ni)</td>
<td>30</td>
<td>25</td>
</tr>
<tr>
<td>mercury (Hg)</td>
<td>1</td>
<td>0.4</td>
</tr>
<tr>
<td>zinc (Zn)</td>
<td>400</td>
<td>200</td>
</tr>
<tr>
<td>chrome</td>
<td>70</td>
<td>0</td>
</tr>
<tr>
<td>chrome VI</td>
<td></td>
<td>0</td>
</tr>
</tbody>
</table>

Compost quality management: Swiss concept

- Swiss legislation: hygienization

  - List of materials, which can be composted or treated by anaerobic digestion
  - Compost:
    - 3 weeks with temperature > 55°C, or
    - 1 week with temperature > 65°C, or
    - other technique with proof of efficacy
  - Digestate:
    - 24 hours with temperature > 53°C, or
    - other technique with proof of efficacy (for example pasteurization prior to AD)
  - Risk material (need permission to be treated): 20 min, by 133°C

Compost quality management: Swiss concept

- Minimum quality requirements: Swiss Legislation
  - FAC guidelines 1995
  - Heavy metals, impurities, hygienisation: ORRChim
  - Objective: no negative impact on the environment

- Swiss compost and digestate guidelines 2010

  - Five product classes
    - Digestate liquid for agricultural use
    - Digestate solid for agricultural use
    - Compost for agricultural use
    - Compost for field horticulture
    - Compost for covered cultures

- Voluntary standard of the compost trade
  - Objective: To avoid problems in relation to utilization of digestate and compost
  - Support for choosing the appropriate product, depending on the utilization
Compost quality and influence on soils and plants

09.11.2012, Tartu (Estonia)

jf, FiBL, CH-Frick

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### Compost quality management: Swiss concept

#### Swiss compost and digestate guidelines 2010

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Digestate liquid</th>
<th>Digestate solid</th>
<th>Compost</th>
<th>Compost for field/for handbook</th>
<th>Compost for covered cultures</th>
</tr>
</thead>
<tbody>
<tr>
<td>DM (dry matter) [% FM]</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>&gt; 50 %</td>
<td>&gt; 55 %</td>
</tr>
<tr>
<td>OM (organic matter) [% DM]</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>&gt; 50 %</td>
<td>&lt; 40 %</td>
</tr>
<tr>
<td>pH</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>&lt; 7.8</td>
<td>&lt; 7.5</td>
</tr>
<tr>
<td>Particle size [mm]</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>&lt; 25</td>
<td>&lt; 15</td>
</tr>
<tr>
<td>Color of extract (X)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>&lt; 1.0</td>
<td>&lt; 0.5</td>
</tr>
<tr>
<td>Salinity [g KCl eq/kg DM]</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>&lt; 20</td>
<td>&lt; 10</td>
</tr>
<tr>
<td>Total nitrogen [g/kg DM]</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>&gt; 10</td>
<td>&gt; 12</td>
</tr>
<tr>
<td>Ammonium [(N-NH₄)] [mg/kg DM]</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>&gt; 3’000</td>
<td>&gt; 600</td>
</tr>
<tr>
<td>Nitrate [(N-NO₃)] [mg/kg DM]</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>&gt; 80</td>
<td>&gt; 160</td>
</tr>
<tr>
<td>Nitrite [(N-NO₂)] [mg/kg DM]</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>&lt; 20 mg/kg DW</td>
<td>&lt; 10 mg/kg DW</td>
</tr>
</tbody>
</table>

Minimal requirements: recommendation: X: has to be mentioned; (X): mention recommended
Compost quality and influence on soils and plants

09.11.2012, Tartu (Estonia)

jf, FiBL, CH-Frick

Compost quality management: Swiss concept

› Evolution of $N_{\text{min}}$ during composting process

Duration of process

Compost quality management: Swiss concept

› Swiss compost and digestate guidelines 2010

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Composts and digestates for agricultural use</th>
<th>Compost for horticultural use</th>
<th>Compost for field fertilization</th>
<th>Compost for covered cultures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total nitrogen (g kg$^{-1}$ DM)</td>
<td>X</td>
<td>X</td>
<td>$&gt; 10$</td>
<td>$&gt; 12$</td>
</tr>
<tr>
<td>Ammonium (N-NH$_4$)</td>
<td>$&gt; 3'000$</td>
<td>$&lt; 600$</td>
<td>$&lt; 50$</td>
<td>$&lt; 40$</td>
</tr>
<tr>
<td>Nitrate (N-NO$_3$)</td>
<td>X</td>
<td>$&lt; 160$</td>
<td>$&lt; 40$</td>
<td>$&lt; 20$</td>
</tr>
<tr>
<td>Nitrite (N-NO$_2$)</td>
<td>(X)</td>
<td>$&lt; 20$ mg/kg DW</td>
<td>$&lt; 10$ mg/kg DW</td>
<td></td>
</tr>
</tbody>
</table>

Minimal requirements; recommendation: (X) has to be mentioned; (X): mention recommended

Compost quality management: Swiss concept

› Evolution of $N_{\text{min}}$ during composting process

Ratio Nitrate : $N_{\text{min}}$

Compost quality management: Swiss concept

› Biotest cress open

> 50% from control

Biotest lettuce

> 50% from control

Biotest cress closed (X)

> 25% from control

Compost quality management: Swiss concept

› Training programme

› Training module

Quality module

process and quality control

simple chemical tests, plant tests

analysis and interpretation of results

installation of a simple laboratory on the composting plant

Duration of process

Graph: Dr. Ulrich Galli

Graph: Dr. Ulrich Galli

Graph: Dr. Ulrich Galli

Graph: Dr. Ulrich Galli

Durin of process
Benefits from utilization of compost

- Effects of compost on the soil
- Macro- and micro-nutrients

Benefits from utilization of compost

- Effects of compost on the soil
- Macro- and micro-nutrients
- Organic matter

Compost quality and influence on soils and plants

09.11.2012, Tartu (Estonia)

Benefits from utilization of compost

- Effects of compost on the soil
- Macro- and micro-nutrients

Benefits from utilization of compost

- Effects of compost on the soil
- Macro- and micro-nutrients
- Organic matter

Bibliography

- Test duration
- Compost quantity
- Effect on OM-content of the soil [in % of control]

- Aichberger and al., 2000
  - 9 years
  - 15-40 t FM / ha
  - +12%

- Bragato and al., 1998
  - 5 years
  - 7.5-15 t FM / ha
  - + 21 %

- Jankinson and al., 1987
  - 140 years
  - manure: 35 t / ha and year
  - + 176 %

- Kjellenberg and Granstedt, 2005
  - 33 years
  - 4 t FM / ha and year
  - + 8 bis + 25 %

- Compost Diffusion, 1999
  - 7 years
  - 40-100 m³ / year
  - +10 % to 37 %
Compost quality and influence on soils and plants

Benefits from utilization of compost

- Reproduction potential of humus

Benefits from utilization of compost

- Effects of compost on the soil
  - Macro- and micro-nutrients
  - Organic matter
  - Soil structure

Benefits from utilization of compost

- Effects on soil porosity

Benefits from utilization of compost

- Effects on soil structure
  - Reduced soil density
    (e.g. 6% in the case of Compost Diffusion)
  - Soil management is easier, saving of fuel
    (observations of FiBL in a test of compost application in fruit growing)

Benefits from utilization of compost

- Effects of compost on the soil
  - Macro- and micro-nutrients
  - Organic matter
  - Soil structure
  - Soil porosity
Compost quality and influence on soils and plants

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Benefits from utilization of compost

- Effects of compost on the soil
  - Macro- und micro-nutrients
  - Organic matter
  - Soil structure
  - Soil porosity
  - Soil aeration
  - Water capacity

Benefits from utilization of compost

- Effects on soil aeration

- Effects of compost on the water capacity of soil

- Compost Diffusion, 1999: + 8%
- Eyras and al., 1998: +20 to +25%
- Gagnon and al., 1998: +3 to +5%
- Shiraliipour and al., 1996: + 3% to +16%

Erosion
Benefits from utilization of compost

- Effects on erosion
  - Reduction of wind-erosion
    - Hartmann, 2002: -30 to -50%
    - De Vos, 1996: same erosion with 4 Beaufort without compost and 6-7 Beaufort with compost
  - Reduction of water-erosion
    - Ojeda and al., 2003: -50%
    - Bazzoffi and al., 1998: -10 to -50%

- Effects on soil structure, soil porosity, soil aeration, water capacity and erosion
  - Effect can be also negative if application of the products is not correct
    - For example: excessive application of liquide digestate in a poor buffered soil can break down its structure (Unterfrauner, 2008)

- Effects on soil pH

- Macro- und micro-nutrients
- Organic matter
- Soil structure
- Soil porosity
- Soil aeration
- Water capacity
- Erosion
- Soil pH

Benefits from utilization of compost

Effects on soil pH

<table>
<thead>
<tr>
<th></th>
<th>Di</th>
<th>Ca</th>
<th>Ch</th>
<th>Cc</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2005</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Di: digestate; Ca: compost for agricultural use; Ch: compost for horticultural use; Cc: compost for covered cultures
Benefits from utilization of compost

- Effects on soil pH
  - Allowed compost quantity (CH): 25 tons DM / 3 years
  - Correspond to 1'500 CaO (500 kg / year)
  - Correspond to maintenance liming quantity
  - Enough to redress pH value?
    - In some soils yes (FiBL trials with corn)

Benefits from utilization of compost

- Effects of compost on the soil
  - Macro- and micro-nutrients
  - Organic matter
  - Soil structure
  - Soil porosity
  - Soil aeration
  - Water capacity
  - Erosion
  - Soil pH
  - Microflora

Benefits from utilization of compost

- Effects on soil microflora
  - Indirect through influence of soil characteristics
  - Supply of nutrients for soil microorganisms
  - Supply of compost microorganisms to the soil
  - Improvement of the microbial balance in the soil
  - Improvement of the soil microbiological activity

Disease control with quality compost

- Influence of compost on plant health and vitality
  - Indirect:
    - supply of macro- and micro-nutrients
    - soil structure
    - humus quantity and quality
    - water regulation
  - Direct:
    - influence of soil microflora through compost and compost microflora

Disease control with quality compost

- Not all composts are equal
Compost quality and influence on soils and plants

09.11.2012, Tartu (Estonia)

Disease control with quality compost
› Quality compost as plant protection agent in practice
› Example 1: Compost in culture substrate

Disease control with quality compost
› Quality compost as plant protection agent in practice
› Example 1: Compost in culture substrate

Buffers the system microbiologically
Prevents pathogen invasion
Reduces disease incidence drastically
Secures plant production

www.fibl.org

Buffers the system microbiologically
Prevents pathogen invasion
Reduces disease incidence drastically
Secures plant production

Disease control with quality compost
› Quality compost as plant protection agent in practice
› Example 1: Compost in culture substrate

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Disease control with quality compost
› Quality compost as plant protection agent in practice
› Example 1: Compost in culture substrate

Buffers the system microbiologically
Prevents pathogen invasion
Reduces disease incidence drastically
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Disease control with quality compost
› Quality compost as plant protection agent in practice
› Example 2: Compost after soil steaming

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Buffers the system microbiologically
Prevents pathogen invasion
Reduces disease incidence drastically
Secures plant production

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Buffers the system microbiologically
Prevents pathogen invasion
Reduces disease incidence drastically
Secures plant production
Disease control with quality compost

› Quality compost as plant protection agent in practice
  › Example 2: Compost after soil steaming
    › Detoxification of the soil
    › Allows earlier planting of seedlings
    › Prevents soil re-colonisation with pathogens
    › Allows sustainable soil steaming

Disease control with quality compost

› Quality compost as plant protection agent in practice
  › Example 3: Compost in the field
    - Reduces disease incidence
    - The more intensively the field is cultivated, the more evident is the positive effect of compost on plant health

Disease control with quality compost

› Quality compost as plant protection agent in practice
  › Example 3: Compost in the field

Disease control with quality compost

› Quality compost as plant protection agent in practice
  › Example 4: Compost effect on the whole plant
Disease control with quality compost

› Quality compost as plant protection agent in practice
  › Example 4: Compost effect on the whole plant

Compost quality management in practice

› Quality management: from collecting the biowaste to compost use
  › Quality of the green waste
  › Composition of the starting mixture
  › Management of composting process
  › Compost storage
  › Choice of the adequate compost for each utilization
  › Compost application strategy

Compost quality management in practice

› Example: Inadequate process management:
  › For example no hygienisation

Compost quality management in practice

› Example: Inadequate storage:
  › For example phytotoxicity

Disease control with quality compost

› Quality compost as plant protection agent in practice
  › Example 4: Compost effect on the whole plant
    › Reduces disease incidence without direct contact with the pathogen
    › Efficacy varies greatly from compost to compost

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Evaluation of compost quality

- With own senses

Evaluation of compost quality

- Contaminants in compost

Evaluation of compost quality

- Smelling test

Evaluation of compost quality

- Fist test

Evaluation of compost quality

- Degree of degradation, structure, compost granularity

Evaluation of compost quality

- With simple analysis
  - Process parameters:
    - O₂
    - moisture
    - temperature
  - Chemical and physical analyses
    - pH
    - salinity
    - NH₄, NO₂, NO₃
  - Biotests
    - phytotoxicity tests
    - disease suppressivity tests
Conclusions

› Quality compost can improve soil fertility and plant growth and health
› Quality management is the key for a successful production and use of compost
› Training and experience are necessary to ensure production of quality compost and its correct use
› The choice of the right product and application strategy is decisive to obtain the desired impact
› The relation between compost producer and compost user has to be improved to assure the future of composts

Thank you very much for your attention ...