Copper and other heavy metals in hop and vineyard soils and their effects on soil coenosis

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Aim and Scope

• Representative assessment of bioavailable heavy metals in hop and vineyard soils

• Effects of site-related factors on heavy metal contents

• Additive, synergistic or antagonistic effects of heavy metals on soil coenosis

• Statements about adaption effects of indicator species to heavy metals in soils
Completed Steps

• **Pre-sampling**
  - Soil sampling in all German vineyard and hop regions
    Soil depth 0-5, 5-20 and 0-20 cm

• **Analysis in laboratory**
  - Total contents in Aqua Regia extraction: Pathway Soil - Human
    DIN ISO 11466: 06.97
  - Plant available contents in Ammonium Nitrate Extraction: Pathway Soil - Plant
    DIN 19730: 06.97
  - Determination of soil parameters as pH-value, soil type, C/N-ratio
    DIN ISO 10390:05.97, DIN 19683-2: 04.97

• **Site selection**: Trial run earthworm monitoring
  - Soil quality -- Sampling of soil invertebrates - Part 1: Hand-sorting and formalin extraction of earthworms
Pre-sampling

Vineyards

Anbaugebiete
- Ahr
- Baden
- Franken
- Hessische Bergstraße
- Mittelrhein
- Mosel-Saar-Ruwer
- Nahe
- Pfalz
- Rheingau
- Rheinhessen
- Saale-Unstrut
- Sachsen
- Württemberg

Standorte der Probenahmen
- Ökologische Bewirtschaftung
- Konventionelle Bewirtschaftung

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Pre-sampling

Hop Gardens

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# Pre-sampling

<table>
<thead>
<tr>
<th>Vineyards</th>
<th># of sites</th>
<th># of samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>273</td>
<td>2086</td>
</tr>
<tr>
<td>Cultivated sites</td>
<td>115</td>
<td>1098</td>
</tr>
<tr>
<td>Reference sites</td>
<td>74</td>
<td>574</td>
</tr>
<tr>
<td>Background sites</td>
<td>84</td>
<td>153</td>
</tr>
<tr>
<td>Add. samples</td>
<td></td>
<td>261</td>
</tr>
</tbody>
</table>
Origin of heavy metals in hop and vineyard soils

<table>
<thead>
<tr>
<th>As</th>
<th>Cr</th>
<th>Cu</th>
<th>Pb</th>
<th>V</th>
<th>Zn</th>
</tr>
</thead>
</table>

- Lead arsenate PbHAsO$_4$ : Insecticide 1890 – 1960
- Copper-chrome-arsenate, copper-zinc-arsenate: formerly used as wood preservative
- Zinc und vanadium: alloyed and zinc-coated metal poles
- Copper as plant protection product since end of 19th century
Results

Plant available heavy metal contents on cultivated, reference and background sites in vineyards

Mean values (soil depth 20 cm)

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Results

Plant available heavy metal contents on cultivated, reference and background sites in hop gardens

Mean values (soil depth 20 cm)
Results

Total copper contents and plant availability on German vineyards

Mean values on cultivated sites (soil depth 20 cm)

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Results

Correlation of total and plant available copper contents in vineyard soils

1098 single values of cultivated sites (soil depth 20 cm, r=0.7)

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Results

Correlation of total and plant available copper contents in hop soils

110 single values of cultivated sites (soil depth 20 cm, r=0.4)

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Plant availability of Cu in relation to pH-value in vineyard soils

Mean values of cultivated site BA_16 (soil depth 20 cm)
Plant availability of Cu in relation to pH-value in hop soils

Mean values of cultivated site BY_09 (soil depth 20 cm)

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Test run earthworm monitoring

$\frac{1}{4}$ m$^2$ digging

0.2% formaline sol.

20-30 min waiting

Lumbricus terrestris

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Perspective

- Bioavailable Cu in CaCl₂: Pathway soil – soil organism

- Identification of extracted earthworms

- Identification of heavy metal contents in earthworms
  - Pressure solution with Nitric Acid (HNO₃)

- Publication in „Journal für Kulturpflanzen“ in Spring 2011
  Special edition „Copper“
Thank you for your attention!