„Gibt die langjährige Anwendung von Kupfer im Rebschutz Anlass zur Sorge für Bodenorganismen?“

"Is the longstanding application of copper in vineyard protection a cause for concern for soil organisms?"

Nadine Herwig, Dieter Felgentreu & Bernd Hommel
Copper research at JKI-ÖPV

- fate, exposition and impact of Cu in vineyards to provide field data
- assessment of risks of Cu on soil organisms

78 areas

Sampling sites
Vine growing regions
- Ahr
- Baden
- Franken
- Hessische Bergstraße
- Mittelrhein
- Mosel-Saar-Ruwer
- Nahe
- Pfalz
- Rheingau
- Rheinhessen
- Saale-Unstrut
- Sachsen
- Württemberg

Nov. 17th/18th, 2016

Dr. Nadine Herwig, European Conference on Copper in Plant Protection
Investigated parameters

Soil
(pedological parameter, metal content and mobility)

Earthworm communities
(habitat, diversity, copper accumulation)

Microorganism
(sum and activity parameters)
Results of the field study - FATE

Copper heterogenity within one cultivated sample area and different regions

- Franken (clayey silt soil)
- Rheinhessen (silty loam soil)
- Mosel (sandy soil)

Heterogenous copper distribution within a sampling area and between different wine growing regions
A higher Cu\textsubscript{total} content lead to higher Cu\textsubscript{mobile} content in soil

The percentage Cu\textsubscript{mobile} content is less than 1%

Multifunctional relations!
Results of the field study – Impact on earthworms

- A higher Cu_{mobile} content in soil leads to higher Cu_{earthworm} content and decreasing BAF for all life forms.

  - „LIMIT“ Cu_{earthworm} < 87 mg kg\(^{-1}\) DM
  - „critical value“ Cu_{mobile} ≥ 1 mg kg\(^{-1}\) DM (in NH\(_4\)NO\(_3\) extract)
Results of the field study – Impact on earthworms

Earthworm diversity in dependence of the Cu mobility

- Earthworm diversity (H) is independent from Cu\textsubscript{mobile} in soil
Results of the field study
- Total impacts

<table>
<thead>
<tr>
<th>Pedological parameter</th>
<th>pH</th>
<th>C</th>
<th>N</th>
<th>C/N</th>
<th>org.S</th>
<th>H₂O</th>
<th>CEC</th>
<th>sand</th>
<th>clay</th>
<th>silt</th>
<th>Cu&lt;sub&gt;total&lt;/sub&gt;</th>
<th>Cu&lt;sub&gt;mobile&lt;/sub&gt;</th>
<th>Zn&lt;sub&gt;total&lt;/sub&gt;</th>
<th>Zn&lt;sub&gt;mobile&lt;/sub&gt;</th>
<th>Cd&lt;sub&gt;total&lt;/sub&gt;</th>
<th>Cd&lt;sub&gt;mobile&lt;/sub&gt;</th>
<th>V&lt;sub&gt;total&lt;/sub&gt;</th>
<th>V&lt;sub&gt;mobile&lt;/sub&gt;</th>
<th>Mo&lt;sub&gt;total&lt;/sub&gt;</th>
<th>Mo&lt;sub&gt;mobile&lt;/sub&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ephemeral</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Biomass</td>
<td>Abundance</td>
<td>Species number</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>anecic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Biomass</td>
<td>Abundance</td>
<td>Species number</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Endemic</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Biomass</td>
<td>Abundance</td>
<td>Species number</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>species number (total)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>abundance (total)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SW-index (H)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Microorganisms</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>qCO₂</td>
<td>C&lt;sub&gt;mic&lt;/sub&gt;</td>
<td>DHA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Spearman Correlation
-1 - 0.8 - 0.5 - 0.2 - 0.2 - 0.5 - 0.8 - 1

Nov. 17<sup>th</sup>/18<sup>th</sup>, 2016
Dr. Nadine Herwig, European Conference on Copper in Plant Protection
Are there any concerns of the future application of Cu PPPs?

**NO!**

Because our results show:

- Low Cu$_{\text{mobile}}$ contents (< 1% of Cu$_{\text{total}}$)
- Adaptation of soil organisms (coevolution, tolerance, resistance) in Cu altered areas
- Heterogenous copper distribution within a sampling area supports resilience of soil organism population
- Impacts due to other parameters (e.g. pedological, management, and toxic elements)
- The none-application of Cu-PPPs on contaminated areas would not lead to an ecological improvement

**BUT under conditions of:**

- Chemical and biological monitoring strategies for areas of concern need to be improved
- Management measures should developed to compensate negative effects of copper pesticides to soil organism
Thank you for your attention!