Mechanisms and dynamics within a biobed

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Structure

- Laboratory studies
  - Pesticide concentration
  - Pesticide mixtures
  - Repeat applications
  - Different soil types
  - Bound residues
  - Tank cleaning agents

- Semi-field experiments
  - Lined vs. un-lined
  - Topsoil vs. Biomix
  - Effect of high water loadings
  - Different soil types
  - “Real world Use”
Pesticides degrade more slowly at higher concentrations, but the effects appear to be less significant in the biomix than in soil.
Pesticide mixtures (Dimethoate)

- Interactions between pesticides are possible, but generally these appear to be less significant in the biobed.
Repeat Applications (Isoproturon)

- The biobed was able to cope with relatively complex mixtures of pesticide applied repeatedly.
Different soil types

<table>
<thead>
<tr>
<th></th>
<th>Wick</th>
<th>Worcester</th>
<th>Blacktoft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand %</td>
<td>69</td>
<td>22</td>
<td>12</td>
</tr>
<tr>
<td>Silt %</td>
<td>13</td>
<td>29</td>
<td>60</td>
</tr>
<tr>
<td>Clay %</td>
<td>18</td>
<td>49</td>
<td>28</td>
</tr>
<tr>
<td>O.C %</td>
<td>1.95</td>
<td>1.5</td>
<td>2.7</td>
</tr>
<tr>
<td>Texture</td>
<td>SCL</td>
<td>C</td>
<td>ZCL</td>
</tr>
<tr>
<td>% of Agricultural land (texture)</td>
<td>14</td>
<td>23</td>
<td>9</td>
</tr>
</tbody>
</table>
Degradation in biomix made with different soils (Mecoprop-P)

% of day 0 concentration vs. Days after treatment

- Sand
- Silt
- Clay
Lined Biobeds

- Biobeds need to be covered to prevent water logging
- Once covered top 10cm became hydrophobic restricting evaporation
- Minimal water loss resulted in saturated conditions below 10cm within 12 months
Lined Biobeds

- High levels of pesticide were retained in the top layer (0-5cm) of the biobed
- Microbial biomass decreased in the top 10cm
  - surface layer drying out
  - inhibitory effect of the pesticide residues
Un-lined Biobeds (ISOPROTURON)

- All pesticides were degraded with <30% of the applied remaining after 9 months
- Concentrations of pesticide in leachate were significantly lower than those from soil
Un-lined Biobeds

- Only the most mobile compounds leached and for these the biomix appeared to retain / degrade >99% of the applied
- The open system removed the necessity to manage water inputs

**HOWEVER.**

- Peak concentrations from biobed lysimeters too high
  (127 µg/l for isoproturon)
- Not considered the effect of additional hydraulic loading from an adjacent filling area.
Additional water loading
**Isoproturon leaching**

- Leaching potential is clearly effected by hydraulic loading.
  - medium loading < 1% of the applied (89µg/l maximum)
How do we improve biobed performance?

- Reduce the hydraulic loading
- Increase the retention time in the biobed (> depth)
- Restrict which pesticides are applied

NEW STUDIES
- 3 Biobed depths
- 3 hydraulic loadings
- 4 mobile pesticides
  - Isoproturon, dimethoate, mecoprop-P and metsulfuron-methyl
Isoproturon

![Graph showing concentration vs depth and loading rate.](image)
Metsulfuron-methyl
How soil type effects leaching in biobeds? (Mecoprop-P)
"Real World Use" (Mecoprop-P)
Conclusions

- Generally biobeds appear to be able to degrade high concentrations of a relatively complex mixture of pesticides when applied repeatedly.
- Water management is crucial:
  - performance
  - cost of construction
  - management
- With the exception of all but the most mobile pesticides (Koc<35) performance was similar to that of more expensive treatment systems with >99.9% of the applied pesticide retained and or degraded within 12 months.
Future Work

Long term monitoring
• Leachate
• Mixture of old and new

Management requirements
• How much, How often
• Fresh or pre-composted
• Retain residues (mobility?)
• Complete replacement (C:N)

Pesticide(s) that don’t degrade
• Identify
• Manipulate

Pesticide that leach
• Modify biobed
• Prevent restrictions

Disposal of biomix
• Direct to land?
• Store / to land?

Risk based technology transfer

Robust Sustainable system