Plant Pathogens in Composted Green Waste: Risk of Transmission

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Sources of info
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Sources of info
Noble et al. (2004) Investigation of the effect of the composting process on particular plant, animal and human pathogens known to be of concern for high quality end uses.

Introduction
- Nothing in life is without risk!
- For pathogens in green waste:
  - Need to understand the risks
  - and manage them
  - Balance the risks against any benefits
Introduction

- **Main concern:**
  - If you use composted green waste are you going to create/introduce new disease problems?
- **WRAP funded us to address this issue**
- **Not a new concern:**
  - Considerable body of published data in the scientific literature esp. from 1980’s and 1990’s

Literature review

- **Examined ca. 80 publications (1926-2003)**
- **Covered 64 pathogens/nematodes**
- **Several problems in reviewing, interpreting and comparing the literature:**
  - different methods
  - differing, poor, or unknown detection limits
  - vague temperature records
  - conflicting results

Literature review

- **Good news and bad news:**
  - Most not detectable after composting for up to 21 d with peak temperatures of 64-70°C
  - Certain pathogens were more temperature tolerant and were not reliably eradicated:
    - *Fungi*: club root of Brassicae, Fusarium wilt of tomato, dry root rot of beans
    - *Viruses*: CGMMV, PMMV, TRV, TMV, ToMV

Consultation with end-users

- **Pathogens most frequently mentioned as being of concern:**
  - *Phytophthora* spp. (root rots)
  - *Pythium* spp. (damping off)
  - *Plasmodiophora brassicae* (club root)
  - *Rhizoctonia solani* (damping off)
  - *Fusarium oxysporum* (wilts)
- **Also for health and safety:**
  - *E. coli*
  - *Salmonella*

Experimental work

- **Pathogens selected**
  - End-user concern, un-reliable or no published data, temperature tolerant
- **Examined in bench-scale system**
  - Infected plant material or propagules added with carrier
- **Tests in commercial systems**
  - Selected pathogens
  - Insulated windrow or tunnel

Pathogens

<table>
<thead>
<tr>
<th>Pathogens</th>
<th>Disease</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Pseudomonas</em> spp.</td>
<td>Tomatoes wilt</td>
</tr>
<tr>
<td><em>Pythium</em> spp.</td>
<td>Fungal leaf blight</td>
</tr>
<tr>
<td><em>Phytophthora</em></td>
<td>Fungal root blight</td>
</tr>
<tr>
<td><em>Rhizoctonia</em></td>
<td>Root and stem rots</td>
</tr>
<tr>
<td><em>Plasmodiophora</em></td>
<td>Club root of Brassicas</td>
</tr>
<tr>
<td><em>Microdochium</em></td>
<td>Fungal root blight</td>
</tr>
<tr>
<td><em>Fusarium</em></td>
<td>Fungal root blight</td>
</tr>
<tr>
<td><em>Bacterial</em></td>
<td>Black root of brassicas</td>
</tr>
<tr>
<td><em>Tobacco mosaic</em></td>
<td>Tobacco mosaic virus</td>
</tr>
</tbody>
</table>
Bench scale

- Constant temperatures
  - 18, 40-70°C in 6°C increments
  - 7 days
- Green waste and onion waste

Bench – pathogen propagules

<table>
<thead>
<tr>
<th>Pathogens</th>
<th>Incubation</th>
<th>Not detected after 7 d at (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fusarium ox. f.sp. lycopersici</td>
<td>Chlamydospores / lab.</td>
<td>46 (green waste) 52 (onion waste)</td>
</tr>
<tr>
<td>F. ox. f.sp. radicis-lycopersici</td>
<td>Chlamydospores / lab.</td>
<td>46 (green waste) 52 (onion waste)</td>
</tr>
<tr>
<td>Microdochium nivale</td>
<td>Chlamydospores / lab.</td>
<td>64</td>
</tr>
<tr>
<td>Phyllosticta nicotianae</td>
<td>Chlamydospores / past</td>
<td>52 (green waste) 58 (onion waste)</td>
</tr>
<tr>
<td>Pythium ultimum</td>
<td>Chlamydospores in chopped potato/soil medium</td>
<td>60 (5 day)</td>
</tr>
<tr>
<td>Alternaria brassicola</td>
<td>Conidia</td>
<td>40</td>
</tr>
</tbody>
</table>

Bench - infected material

<table>
<thead>
<tr>
<th>Pathogens</th>
<th>Incubation</th>
<th>Not detected after 7 d at (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fusarium oxysporum f.sp. lycopersici</td>
<td>Tobacco plants</td>
<td>46 (green)</td>
</tr>
<tr>
<td>Thielaviopsis basicolla</td>
<td>Conidia</td>
<td>50 (5 day, moisture affects) 52 (1 day, 61% moist.)</td>
</tr>
<tr>
<td>Phoma brassicae</td>
<td>Conidia</td>
<td>50 (1 day)</td>
</tr>
<tr>
<td>Verticillium dahliae</td>
<td>Oat grains</td>
<td>50 (1 day)</td>
</tr>
<tr>
<td>Rhizoctonia solani</td>
<td>Barley grains</td>
<td>46 (green) 44 (onion)</td>
</tr>
<tr>
<td>Xanthomonas campestris</td>
<td>Brassica leaves</td>
<td>40</td>
</tr>
<tr>
<td>Phytophthora nicotianae</td>
<td>Tobacco leaves</td>
<td>80 (survived at 70)</td>
</tr>
</tbody>
</table>

Bench scale

- Green waste - pH 6.8, moisture 43%
- Onion waste – pH 4.3, moisture 75%
  - low pH, high moisture = less favourable for aerobic bacterial activity than green waste?

Commercial systems

- Systems
  - Insulated aerated tunnels
  - Turned windrows
- Infected plant material
  - mesh bags
  - 50 cm depth
- Temperatures monitored with probes and electronic logger
**Commercial systems**

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Inoculum</th>
<th>Not detected after 7 d at</th>
<th>°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plasmodiophora brassicae</td>
<td>Tomato plants</td>
<td>&gt;65 for 3 days, peak 70</td>
<td></td>
</tr>
<tr>
<td>Plasmodiophora brassicae</td>
<td>Oat grains</td>
<td>&gt;60 for 2 days, peak 70</td>
<td></td>
</tr>
<tr>
<td>Verticillum dahliae</td>
<td>Oat grains</td>
<td>&gt;60 for 2 days, peak 70</td>
<td></td>
</tr>
</tbody>
</table>

**Conclusions**

- **Main concern:**
  - If you use composted green waste are you going to create/introduce new disease problems?

- **Answer:**
  - Probably not unless you are planning to grow certain higher risk crops

- **Assurance**
  - Composting done properly according to PAS100 standards (min 55°C for 7 or 14 d)

- **If growing high risk crops (e.g. brassicas, TMV susceptible tomatoes, turf)**
  - either:
    - need assurance that higher temperatures (>65°C) have been achieved in the batch and / or:
    - test for the presence of the specific pathogen of concern

- **Testing for pathogens**
  - no standard protocols developed, agreed or validated
  - consider assay design
    - sampling and sample size
    - detection limits and sensitivity
    - tolerance standards
  - no such thing as ‘zero’ only ‘not detected’ or ‘less than ….’
  - expect to have results reported with indications of detection limits/sensitivity

- **Key factors during composting:**
  - minimum temperatures must be achieved throughout the bulk, not just in the core
  - if not turned, monitoring should be done near the surface (i.e. ~ 10 cm)
  - >51% initial moisture for reliable eradication of club root
Finally

- Remember nothing is without risk
- We can minimise the risk of most pathogens in green waste by ensuring adequate temperatures are achieved during the composting process
- Balance these risks against the potential benefits (e.g. to the environment and from disease and weed suppression)

The end

Thank you for listening