Disease Suppression
With Composts

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Common Use of Composts in Agricultural Systems

- Soil conditioners
- Soil fertilizers
- Soil potting medium
- Disease suppressors?
Hardwood Bark Compost Control of Phythium Root Rot

Peat Mix

With Compost

Source: H. Hoitink
Hardwood Bark Compost Control of Phytophthora Collar Rot of Apple

Peat Mix

Compost Mix

Source: H. Hoitink
Findings

- Composted red oak bark was suppressive to many soilborne fungal pathogens if
  - Medium had good drainage
  - Medium allowed to mature
  - Medium colonized by beneficial microorganisms
  - Medium low in salts and available nitrogen

- Compost required “extra maturity” and addition of inoculant for suppression to *Rhizoctonia solani* and *Sclerotium* spp.

- Not effective against weeds, microarthropod and nematode pests
Compost Process and Presence of Antagonist Microorganisms

Antagonists
- Fungi
  - Trichoderma
  - Gliocladium

Bacteria
- Bacillus
- Pseudomonas
- Streptomyces
How Do Composts Work?
Mode of Action of Compost

- Direct
  - Modified rooting environment
  - Microbial antagonists – Biological Control

- Indirect
  - Systemic Induced Resistance
Direct Effect – Biological Control

Immature Compost
- Available nutrients
- Ready sources of substrates
- Antagonists become saprophytic
- Pathogens flourish and cause disease

Mature Compost
- Available nutrients low
- Recalcitrant sources of substrates
- Antagonists become competitive and parasitic to pathogens
- Pathogens die

Source: Benhamou and Chet 1993 Phytopathology 83:1062-1071
Systemic Induced Resistance

- Beneficial soil organism prepares plant to defend against pathogens

- *Trichoderma hamatum* added to compost

- *Colletotrichum orbiculare* added as foliar pathogen

Source: H. Hoitink
Where Compost is Suppressive

- Potting medium
  - *Damping off* ([*Pythium*, *Rhizoctonia*])
  - Root rot ([*Phytophthora*])
  - Wilts ([*Fusarium*, *Verticillium*])

- Mode of action?
  - pH control
  - Drainage
  - Biological control
  - Systemic Induced Resistance
Response in Greenhouse Tomato to Suppressive Compost and *Fusarium*

Response of Bioassay Plant (Arabidopsis) to Compost

14 Days

28 Days

Not all Composts are Suppressive

Example *Verticillium* in *Arabidopsis*

Where Compost is Suppressive

- Turfgrass top-dressing
  - Fusarium patch
  - Red thread (*Laetisaria*)
  - Damping-off
  - Brown patch (*Rhizoctonia*)
  - Dollar spot (*Sclerotinia*)
  - Snow mould (*Typhula*)

- Grass clipping compost inoculated with *Bacillus subtilis*

- Mode of action?
  - Biological control
  - Turf health
Compost to Turf

Source: E. Nelson
Suppression With Microbial Activity of Brewery Compost to Turf

Pythium damping-off

Microbial Activity

I'm collecting manure for my strawberries.

I always put cream and sugar on mine.
CMCDC Potato Early Dying Field Study

3 years experiment

1st year 2nd year 3rd year

2006 2007 2008

Green Manure Amendments

Wheat Wheat/Wapam Wheat
Oriental mustard Yellow mustard
Canada milk vetch Sorghum/Sudan Sorghum/Sudan
Oat/Peas Fall – Rye Compost/Wheat
Alfalfa Potato Mustard meal/Potato

Block I Block II Block III Block IV
Soil Building Green Manures

Fall Rye

Alfalfa

Oat/Peas

Composted cattle manure
44.5 wet ton. ha$^{-1}$
Trap crops

Sorghum Sudan grass

“Trick pathogens to thinking host is available but then die”
Toxicity to MS

Decomposition of organic amendments can release volatile and non-volatile toxic compounds.

Biofumigation

Use of chemical that naturally occur in the Brassica family of plants to suppress soil-borne disease.

Mustard seed meal.
0.5% v/v.
Germination of Verticillium

Wheat Control
Mustard meal
Vapam
Oat/peas
Milk Vetch
Sorghum (2 years)
Sorghum (1 year)
Fall rye
Oriental mustard
Yellow mustard
Alfalfa (2 years)

% germination

Treatments

Mustards
Verticillium Density in Soil

Vertical bar = standard error. n=4
Verticillium Incidence

*Means with different letters are significant different according to the Duncan’s protected least difference (P ≤ 0.05).

Pearson’s correlation coefficient r for inoculum density of *V. dahliae* and *Verticillium* wilt incidence

$r=0.72 \quad p<0.007$
Effect on Total Tuber Yield

Pearson’s correlation coefficient $r$ for potato yield and *Verticillium* wilt incidence

Effect of green manure and organic amendments treatments on total tuber yield

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Yield (cwt. acre$^{-1}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat Control</td>
<td>300 ± 50</td>
</tr>
<tr>
<td>Compost</td>
<td>350 ± 70</td>
</tr>
<tr>
<td>Mustard meal</td>
<td>250 ± 40</td>
</tr>
<tr>
<td>Vapam</td>
<td>320 ± 60</td>
</tr>
<tr>
<td>Oat/peas</td>
<td>310 ± 50</td>
</tr>
<tr>
<td>Milk Vetch</td>
<td>330 ± 60</td>
</tr>
<tr>
<td>Sorghum (2 years)</td>
<td>340 ± 70</td>
</tr>
<tr>
<td>Sorghum (1 year)</td>
<td>350 ± 80</td>
</tr>
<tr>
<td>Fall rye</td>
<td>360 ± 90</td>
</tr>
<tr>
<td>Oriental mustard</td>
<td>370 ± 100</td>
</tr>
<tr>
<td>Yellow mustard</td>
<td>380 ± 110</td>
</tr>
<tr>
<td>Alfalfa (2 years)</td>
<td>390 ± 120</td>
</tr>
</tbody>
</table>

$r = -0.82$, $p < 0.001$
Amendments and Green Manures on Potato

0

0

0
Compost Addition to Winkler-CMCDC Soil

![Graph showing the yield of Russet Burbank and Umatilla Russet in non-saline and saline conditions with and without compost addition.](graph.png)

Composted cattle manure 80 t ha$^{-1}$
Compost and Mustard Meal Addition to Winkler Soil

Composted cattle manure 80 t ha\(^{-1}\); meal 10 t ha\(^{-1}\)
Lower Rate Compost (20 t ha\(^{-1}\))

- Cattle manure compost 20 t ha\(^{-1}\) in 2010 to clay loam
- Rate equivalent to total amount K fertilizer recommendation
- CMCDC-Winkler site on saline and non-saline soil
- Russet Burbank and Umatilla Russet grown
- No yield benefit with compost addition at this rate
THE DOCTOR SAYS THE FERTILITY TREATMENTS ARE GOING VERY WELL!
How May Compost Be Effective?

- Two studies on commercial potato fields in Manitoba show relation of soil organic matter (%) to Potato Early Dying
- One study was a survey of 22 fields done in 2003
- Other study was done on 4 fields in 2004 where there were diseased and healthy patches
Survey of 22 Fields

Effect of Soil Organic Matter on Potato Early Dying Incidence in Manitoba

Tenuta et al. in preparation
Study of Diseased and Healthy Patches

Equation: Wilt \( \text{Arc sin sqrt} \) = 1.82 - 4.46 OM \( \text{Arc sin sqrt} \)  
\[ R^2 = 0.12; \ P = 0.003 \]

Equation: Wilt \( \text{Arc sin sqrt} \) = 1.21 - 4.21 OM \( \text{Arc sin sqrt} \)  
\[ R^2 = 0.23; \ P = 0.0001 \]

Briar et al. in preparation
Conclusion

- Composts effective against root rots and damping-off diseases
- Effective as potting medium or turfgrass top-dressing
- Bark, grass clipping and brewery composts most effective to date
- Immature compost can aggravate disease
- Mode of action numerous
- Efficacy improved with inoculation of antagonists
- Compost beef cattle manure seems to reduce Potato Early Dying disease and improve yield
THE MAFIA GOES GREEN...

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100% ORGANIC
Now with:
MOUSE
BADA BANG!
For your Garden & Lawn

$8.00

I FOUND A TUPEE, A FAKE ROLEX AND A BULLET IN A BAG OF THAT STUFF.
Hardwood Bark Compost

- Red Oak bark particles 0.5-2.5cm
- High cellulose content
- With nitrogen addition rapid composting occurs (Phase I, II, III)
- Mature compost suppressive to many diseases
  - Fungicidal inhibitors
  - Colonized with antagonist microflora
  - Excellent porosity – rapid drainage
Suppressive Bark Compost Recipe

- Fresh ground hardwood bark or brush
- One of the following nitrogen sources
  - 0.3 kg N/m³ as fertilizer
  - Grass clippings 10-20% of volume
  - Poultry manure or sewage compost 10-15%
- Maintain moisture at 60-70% of weight
- Minimum of 6 weeks till mature
- Inoculate with antagonists after peak heating
- If not inoculated allow mature for 3 months

Suppressive Turf Compost Recipe

- Fresh grass clippings
- 10:1 (clipping:mature compost) by weight
- 1 day at 80°C
- Cooled to 23°C and inoculated with *Bacillus subtilis*
- 3 days at 40°C
- 7 days at 70°C
- Throughout moisture at 40-55% by weight

Verticillium Soil Population Determinations

Pathogen ➔ *Verticillium dahliae*

1. Inhibition of microsclerotia. (Germination %)

2. Inoculum density. (# of microsclerotia . g⁻¹ of soil)