Reducing Soil-Borne Diseases of Potatoes using Shellfish Processing Waste and Compost

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Chitin – In Nature

Marine Invertebrates

Insects and Arachnids

Fungi and Algae
Chitin

- non-toxic, biodegradable, naturally-occurring polysaccharide
- second most abundant natural polymer after cellulose
Shellfish Processing Waste

- 14 – 35% chitin (dry weight basis)
- 2 - 4% Nitrogen
- 15 - 20 % Calcium
Applications

Health Care
• wound dressing and healing
• surgical sutures
• arthritis
• orthopaedics
• pharmaceuticals
• cosmetics

Food and Beverages
• preservative/stabilizer
• anticholesterol and fat-binding
• flavours and tastes

Waste Treatment
• removal of metal ions
• purify drinking water
• pools and spas
• product separation and recovery

Agriculture
• insecticides
• fungicides
• seed, in-furrow,
• foliar and post-harvest treatments
Possible mechanisms of disease control

- antimicrobial properties

- stimulation of host resistance mechanisms

- enhance complement of beneficial bacteria and fungi
  - chitinolytic species – this work
  - competitive effects
  - direct antibiosis
Successful disease control reports

- common scab of potato
- grey mold of fruits
- blue mold of fruits
- Fusarium crown and root rot of tomato
- green mold of citrus
- downy mildew of grapes
- powdery mildew

Only a handful of registered products available.
Objectives

- Is shellfish waste and shellfish waste compost an effective source of plant nutrition and biological control method for soil-borne fungi diseases of potatoes?

- Is disease suppression related to the complex of soil organisms?
Methodology

Cultivar: Superior (white skin and flesh)

Field Treatment:
A. raw lobster waste - 10,000 lbs/ac
B. compost – 10,000 lbs/ac
C. conventional fertilizer (control) 120 N

Application: Banded or Broadcast

Field Design: 4 replications, 6 plots/rep
Making a seafood based compost, with moderate N release ability

- Lay down 12 inch bed of straw
- Add shell waste
- Cover with wet sawdust
Seafood Compost - next step

- Add second layer of shell waste
- Add wet partially decomposed straw
- Turn for mixing 2x
Seafood Compost @ 35 days 44 C, with good odour and texture

- Day 12 no heat, added water and more waste
- Turned twice weekly for aeration
Lobster Processing Waste

Compost
Experimental Set-up

Banding

Broadcast
Emergence Issues
Chlorophyll Meter - August
## Chlorophyll Meter Readings - August

<table>
<thead>
<tr>
<th>Treatment</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>Synthetic Fertilizer (control)</td>
<td>36.5b</td>
<td>na</td>
<td>40.0a</td>
</tr>
<tr>
<td>Raw lobster waste</td>
<td>40.4a</td>
<td>na</td>
<td>40.4a</td>
</tr>
<tr>
<td>Composted lobster waste</td>
<td>33.7c</td>
<td>na</td>
<td>35.8b</td>
</tr>
</tbody>
</table>
## Soil pH - September

<table>
<thead>
<tr>
<th>Treatment</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>Synthetic Fertilizer (control)</td>
<td>5.1b</td>
<td>5.1b</td>
<td>5.7c</td>
</tr>
<tr>
<td>Raw lobster waste</td>
<td>5.4ab</td>
<td>4.9b</td>
<td>6.0b</td>
</tr>
<tr>
<td>Composted lobster waste</td>
<td>6.0a</td>
<td>5.7a</td>
<td>6.5a</td>
</tr>
</tbody>
</table>

Amendments increase pH – good and bad - scab
Diseases caused by Rhizoctonia

stem and stolon canker

black scurf
### Average number of diseased potato stolons

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<thead>
<tr>
<th>Treatment</th>
<th>2003</th>
<th>2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fertilizer</td>
<td>9.1 a</td>
<td>16.4 a</td>
</tr>
<tr>
<td>Lobster Waste</td>
<td>5.8 b</td>
<td>7.3 b</td>
</tr>
</tbody>
</table>
## Mean Severity of Black Scurf

(\% of tuber surface covered)

<table>
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<tr>
<th>Treatment/Application</th>
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<tbody>
<tr>
<td>Synthetic Fertilizer (control)</td>
<td>5.0a</td>
<td>5.7a</td>
</tr>
<tr>
<td>Raw lobster waste</td>
<td>na</td>
<td>3.0b</td>
</tr>
<tr>
<td>Composted lobster waste</td>
<td>3.9ab</td>
<td>5.0a</td>
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**General reduction**
% Ca in tuber tissue

More calcium better potatoes store
- Important part of the potato skin
- prevents disease penetration
- aids in wound healing

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<th>Treatment</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Compost</td>
<td>0.18</td>
<td>0.22</td>
</tr>
<tr>
<td><strong>Fertilizer</strong></td>
<td><strong>0.14</strong></td>
<td><strong>0.21</strong></td>
</tr>
<tr>
<td>Raw</td>
<td>0.20</td>
<td>0.27</td>
</tr>
</tbody>
</table>
Total Yield (t/ha)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Banded</th>
<th></th>
<th>Broadcast</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2002</td>
<td>2003</td>
<td>2002</td>
<td>2003</td>
</tr>
<tr>
<td>Compost</td>
<td>20.9b</td>
<td>18.5a</td>
<td>19.6b</td>
<td>17.6a</td>
</tr>
<tr>
<td>Fertilizer</td>
<td>29.5a</td>
<td>21.9a</td>
<td>25.5ab</td>
<td>19.8a</td>
</tr>
<tr>
<td>Raw</td>
<td>6.6c</td>
<td>24.3a</td>
<td>30.0a</td>
<td>19.9a</td>
</tr>
</tbody>
</table>
Barley Yields - KG / Ha (organic management)

- Control
- Fall Compost
- Fall Shell
- Spring Compost
- Spring Shells

Year:
- 2003
- 2004

Yield:
- 0
- 500
- 1000
- 1500
- 2000
- 2500
- 3000
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<tbody>
<tr>
<td>Synthetic Fertilizer (control)</td>
<td>1.70</td>
<td>0.44</td>
<td>0.48</td>
</tr>
<tr>
<td>Raw lobster waste</td>
<td>2.43</td>
<td>0.82</td>
<td>1.35</td>
</tr>
<tr>
<td>Composted lobster waste</td>
<td>3.04</td>
<td>0.41</td>
<td>0.84</td>
</tr>
<tr>
<td>Mean</td>
<td>2.39a</td>
<td>0.56b</td>
<td>0.89b</td>
</tr>
</tbody>
</table>

Differences between years
Microorganism Growth on Chitin-Amended Medium

#'s of colony forming units which use chitin as a food
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<th>2004</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Synthetic Fertilizer</td>
<td>0.91</td>
<td>0.22</td>
<td>0.70</td>
<td>0.61b</td>
</tr>
<tr>
<td>Raw lobster waste</td>
<td>1.95</td>
<td>0.28</td>
<td>0.88</td>
<td>1.04a</td>
</tr>
<tr>
<td>Composted lobster waste</td>
<td>2.16</td>
<td>0.29</td>
<td>0.76</td>
<td>1.07a</td>
</tr>
<tr>
<td>Mean</td>
<td>1.67a</td>
<td>0.26c</td>
<td>0.78b</td>
<td></td>
</tr>
</tbody>
</table>
Fungi CFUs (x 10^7)/ g dry soil on Chitin-Amended Medium

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<th>2003</th>
<th>2004</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Synthetic Fertilizer</td>
<td>0.46</td>
<td>0.07</td>
<td>0.25</td>
<td>0.26b</td>
</tr>
<tr>
<td>Raw lobster waste</td>
<td>0.95</td>
<td>0.17</td>
<td>0.47</td>
<td>0.53a</td>
</tr>
<tr>
<td>Composted lobster waste</td>
<td>0.99</td>
<td>0.12</td>
<td>0.31</td>
<td>0.47a</td>
</tr>
<tr>
<td>Mean</td>
<td>0.80a</td>
<td>0.12c</td>
<td>0.34b</td>
<td></td>
</tr>
</tbody>
</table>
Summary – Shellfish Waste

- increased Ca in tubers
- enhanced communities of beneficial soil microorganisms
- source of nutrition for plant growth
- soil-borne disease suppression
- organic production
Acknowledgments

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