Citrus Postharvest Decay Control: Synthetic Fungicides and Natural Products

The Impact of Citrus Fruit Decay for Florida Citrus Industry

- Citrus diseases can cause significant losses for growers, packers, shippers, and consumers.
- Postharvest losses are usually greater than are often realized because of added cost of harvesting and handling.

Major postharvest decays on Florida citrus

Green mold—Penicillium digitatum

Diplodia stem-end rot—Diplodia natalensis

Sour rot—Goetrichum candidum
Blue mold—*Penicillium italicum*

Anthracnose—*Colletotrichum gloeosporioides*

Phomopsis stem-end rot—*Phomopsis citri*

Brown rot—*Phytophthora palmivora or P. nicotianae*

**Postharvest Decay Control Practices**

Postharvest decay control in Florida is conducted by an integrated system using fungicides as the core.

- Minimize fruit injury during fruit harvesting and handling
- Postharvest drenching
- Minimize ethylene concentration and degreening time
- Pre-washing with sanitizers
- Postharvest washing
- Aqueous fungicide application
- Wax containing fungicides
- Packinghouse and storage room sanitation
- Low temperature refrigeration

**Synthetic fungicides on citrus**

- Sodium o-phenylphenate (SOPP)
- Thiabendazole (TBZ)
- Imazalil
Potential problems associated with currently used fungicides

- Only three registered fungicides
- Hazard risks, residues
- Regulatory issues
- Pathogen resistance
- Economic costs
- No alternative methods in place

Evaluation of new synthetic fungicides for postharvest decay control

- Two new fungicides from Janssen Pharmaceutica Inc. are in the process of being evaluated for decay control.
- Janssen is in the process of registering at least one new chemical for postharvest treatment.

Reduced risk chemical

- Abound (Azoxystrobin) from Zeneca Inc.
- Abound has been registered for citrus preharvest use.
- California is pursuing Abound registration for citrus postharvest use.

Develop alternative postharvest decay control methods using safe and natural products

- Evaluate commercial natural products for postharvest decay control.
- Develop biocontrol agents for postharvest decay control.
- Discover naturally-occurring compounds for decay control.

Evaluation of commercial natural products

- Messenger
- Three bicarbonate based products

Effects of bicarbonate-based products on green mold of inoculated citrus fruit
Biocontrol agent development

- Commercially registered biocontrol agents -- Biosave 1000 (EcoScience Inc.) and Aspire (Ecogen Corporation).

- Biocontrol agent development by FDOC Scientific Research -- biocontrol agents based on Bacillus spp.

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Effect of Bacillus subtilis on green mold of ‘Valencia’ fruit using a fruit inoculation method

Expt. no. (5 days after inoculation)

<table>
<thead>
<tr>
<th>Expt. 1</th>
<th>Control 75.0</th>
<th>B. subtilis GB03 33.3</th>
<th>B. subtilis GB07 0.0</th>
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</thead>
<tbody>
<tr>
<td>Expt. 2</td>
<td>Control 90.0</td>
<td>B. subtilis GB03 75.0</td>
<td>B. subtilis GB07 15.0</td>
</tr>
<tr>
<td>Expt. 3</td>
<td>Control 83.3</td>
<td>B. subtilis GB03 50.0</td>
<td>B. subtilis GB07 10.0</td>
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<tr>
<td></td>
<td></td>
<td>Bacillus spp. B-1-9 5.0</td>
<td>Bacillus spp B-2-2 50.0</td>
</tr>
<tr>
<td>Expt. 4</td>
<td>Control 66.7</td>
<td>B. subtilis GB07 25.0</td>
<td>Bacillus spp B-1-7 5.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bacillus spp B-1-9 15.0</td>
<td>Bacillus spp B-1-9 10.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bacillus spp B-3-3 35.0</td>
<td>Bacillus spp B-1-6 60.0</td>
</tr>
</tbody>
</table>

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Effect of Bacillus subtilis on green mold of ‘Valencia’ fruit using a simulated commercial application procedure (Study 2001-02-D)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>% Decay</th>
</tr>
</thead>
<tbody>
<tr>
<td>B. subtilis GB07</td>
<td>1.8 B</td>
</tr>
<tr>
<td>TBZ</td>
<td>2.8 B</td>
</tr>
<tr>
<td>Control</td>
<td>10.6 A</td>
</tr>
</tbody>
</table>

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Bacterial concentration (log cells/ml)

% Decay

0 2 4 6 8 10

0 20 40 60 80 100 120

Correlation between percentage decay and Bacillus subtilis GB07 concentrations

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Effect of Bacillus subtilis GB07 on green mold on ‘Valencia’ orange under different temperatures

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Ultimate Research Goal

Establish an effective, integrated citrus postharvest decay control system for the Florida citrus industry. This system includes physical, chemical and biological methods.