New Trends in Minimizing Postharvest Disease Losses

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Postharvest Losses (%)

<table>
<thead>
<tr>
<th>Location</th>
<th>Developed Countries</th>
<th>Developing Countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>From Production to Retail</td>
<td>2 - 23</td>
<td>5 - 50</td>
</tr>
<tr>
<td>At Retail, Food service and Consumer</td>
<td>5 – 30</td>
<td>2 – 20</td>
</tr>
<tr>
<td>Cumulative Total</td>
<td>7 – 53</td>
<td>7 - 70</td>
</tr>
</tbody>
</table>

Postharvest Losses

- Range from 7 to 70%
- Quantity losses - not Quality losses
- Causes
  - Mechanical injury
  - Physiological – Chilling
  - Disease

Non-Technical Causes of Losses

- Lack of facilities
  - Temperature / Handling
- Lack of appreciation for proper product handling

Shipper ↔ Wholesaler ↔ Retailer ↔ Consumer
Product & Information

Papaya Postharvest Losses

- Upwards of 70% in some retail settings
- Average losses around 25%
- Losses often reported as due to disease but frequently related to mechanical injury and chilling injury

Commercial Concerns

Papaya
- Need to harvest at color break
  - Determines harvest schedule
  - Harvest & handling major cost
- Storage limitation
  - Chilling injury & rapid ripening
- Disorders
  - Low sugars
  - Ca deficiency
  - Freckling
- Disease – Pre & postharvest
- Insect disinfestation
  - Vapor heat and irradiation
Disorders

- Low sugars <11.5% TSS
  - Variety Line #801 – 8%, SunUp 13%
- Harvesting immature fruit
- Loss of leaf area
  - 2 kg fruit per mature leaf
- Freckling of skin
  - Non pathogenic, burst latifiers
  - Associated late stage fruit development
    - Rain two months before harvest
  - Varies with variety and season
- Ca\(^{2+}\) deficiency – rapid fruit softening
  - Drought followed by rain 2 to 3 months before harvest, low fruit mesocarp Ca\(^{2+}\)

Storage limitations

- Chilling Injury
  - Chilling temperatures
    - Loss during to chilling injury
    - If removed before injury still able to ripen – extra days

Diseases

- Preharvest
  - Anthracnose
  - Phytophthora
- Postharvest
  - Stem end rots
  - Body rots

Postharvest Disease Organisms

- Stem End Rots
  - Ascochyta caricae-papaya, Botryodiplodia theobromae, Fusarium sp., Mycosphaerella sp., Phomopsis sp., Rhizopus stolonifer
- Anthracnose & Chocolate Spot
  - Colletotrichum gloeosporioides
- Other Rots
  - Alternaria alternata, Fusarium sp., Guignaria sp., Rhizopus stolonifer, Stemphyllium sp.

Disease Control

- Preharvest Disease Control
  - Resistant Varieties
  - Field sanitation
  - Pesticide program
    - Anthracnose – Infects and waits for fruit ripening.
- Harvest and Handling – avoid mechanical injury
- Stem End Rots associated broken peduncle
- Body Rots often associated mechanical injury.
- Postharvest Disease Control

Postharvest Disease Control

- Handling to avoid injury & sanitation
- Physical
  - Hot water immersion – 20 minutes at 49°C
  - Hot water sprays – 3 minutes at 54°C
- Storage Environment – temperature and RH
- Chemicals
  - Synthetic Chemicals – Fungicides – Pathogen Resistance, Public Concern of Residues and Cost
  - Natural Chemicals – Neem, Mint, Acetic acid,
- Salts & Other Chemicals – bicarbonate, ozone
- Biocontrol
### Postharvest Disease Control

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Disease Free %</th>
<th>Stem End Rots %</th>
<th>Anthracnose %</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Fungicide</td>
<td>3</td>
<td>92</td>
<td>34</td>
</tr>
<tr>
<td>Fungicide</td>
<td>54</td>
<td>16</td>
<td>23</td>
</tr>
<tr>
<td>Spray 3 min. 54°C</td>
<td>73</td>
<td>0</td>
<td>19</td>
</tr>
<tr>
<td>Immersion 20 min. 49°C</td>
<td>84</td>
<td>1</td>
<td>6</td>
</tr>
</tbody>
</table>

Couey et al., 1984. Plant Disease 68:436

### Hot water treatment of papaya.

### Heat Induced Hard Lumps in Fruit

Heat induced hard lumps in fruit.

### Biocontrol

- **Postharvest Fungicides**
  - Loss Benomyl, Thiabendazole
  - Need to reduce residues
  - Increased resistance to fungicides
- **Cost of fungicides**
- **Alternatives generally not as effective**
- **Need is use a systems approach that integrates a number of approaches including biocontrol**

### Pineapple – Black Rot

- **Disease Control**
  - Minimize fungicide usage
  - Biocontrol for organic production.

**Pineapple Yeast Isolate and Incidence of Black Rot**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Incidence %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>0c</td>
</tr>
<tr>
<td>Chalara inoculated</td>
<td>38a</td>
</tr>
<tr>
<td>Pichia then Chalara 0.5 hr later</td>
<td>21b</td>
</tr>
</tbody>
</table>

Reyes et al., 2004. Postharvest Biology & Technology 33:193

### Papaya - Biological Control

- **Seventy epiphytic yeasts and two bacteria isolated.**
- **Assayed their antagonistic action against Anthracnose**
- **Applied antagonistics**
  - Same day
  - Two and three days after pathogen
### Biocontrol Effectiveness

<table>
<thead>
<tr>
<th>Days</th>
<th>Control</th>
<th>#581</th>
<th>#1061</th>
<th>#1081</th>
<th>#YB</th>
<th>Control</th>
<th>#581</th>
<th>#1061</th>
<th>#1081</th>
<th>#YB</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>73</td>
<td>38</td>
<td>50</td>
<td>58</td>
<td>37</td>
<td>11</td>
<td>6</td>
<td>7</td>
<td>11</td>
<td>7</td>
</tr>
<tr>
<td>11</td>
<td>92</td>
<td>66</td>
<td>66</td>
<td>75</td>
<td>30</td>
<td>12</td>
<td>19</td>
<td>22</td>
<td>23</td>
<td></td>
</tr>
</tbody>
</table>

Yeast isolates applied the same day and evaluated 7, 9 and 11 days after pathogen inoculation.

### Biocontrol Application Time

<table>
<thead>
<tr>
<th>Application</th>
<th>Control Incidence</th>
<th>Yeast #581 Incidence</th>
<th>Bacteria (Yellow) Incidence</th>
<th>Same day</th>
<th>58</th>
<th>14</th>
<th>42</th>
<th>7</th>
<th>8</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2 days</td>
<td>78</td>
<td>16</td>
<td>38</td>
<td>10</td>
<td>63</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3 days</td>
<td>92</td>
<td>22</td>
<td>75</td>
<td>15</td>
<td>63</td>
<td>20</td>
</tr>
</tbody>
</table>

Yeast and bacteria antagonists applied on the same day and four days after pathogen. Evaluated 9 days after pathogen application.

### Application Time on Effectiveness of Biocontrol

<table>
<thead>
<tr>
<th>Application</th>
<th>Incidence (% reduction)</th>
<th>Severity (% reduction)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>#581</td>
<td>#1061</td>
</tr>
<tr>
<td>Same day</td>
<td>57</td>
<td>37</td>
</tr>
<tr>
<td>2 days after</td>
<td>32</td>
<td>41</td>
</tr>
<tr>
<td>3 days after</td>
<td>10</td>
<td>19</td>
</tr>
<tr>
<td>4 days after</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Effectiveness of the biocontrol was the % reduction of incidence and severity from control evaluated 9 days after pathogen application. Antagonists was applied different days after pathogen application.

### Conclusions
- Three yeast isolates show possibility
- Delayed application of antagonist reduce the effectiveness
- Variation in pathogen susceptibility among population
  - Difference in tree characteristics!
  - Antagonist population on the fruit?
- Different application method
- Combined with other biocontrol agents

### Interventions to Reduce Postharvest Losses
- New cultivars with longer postharvest-life and increased disease resistance
- Improved temperature and humidity management
- Improved packaging
- Improved postharvest sanitation and disease control – including biocontrol as part of an integrated system
- More frequent deliveries to retail markets
- Increased training of produce handling personnel
Strategies for Improving Postharvest Handling

- Application of current knowledge to improve the handling systems of horticultural perishables and assure their quality and safety
- Removing the socio-economic constraints, such as inadequacies of infrastructure, poor marketing systems, and weak R&D capacity.
- Overcoming the limitations of small-scale operations by encouraging consolidation and vertical integration among producers and marketers of each commodity or group of commodities.

Acknowledgements

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Questions?