Integrated food safety and plant health approach to controlling microbial hazards in greenhouse tomatoes

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Outline

1. Food safety of fresh fruits and vegetables
2. Outbreaks linked to tomato
3. SCRI Objectives
4. Greenhouse survey
5. Propagation/greenhouse production process flow
6. Probability of plant diseases and contamination with human pathogens
7. What is to follow?
8. Questions
Background

Fresh fruits and vegetables are a top public health priority globally

- Nutritional benefits
- Number of outbreaks, frequency and severity of illnesses

- Size and scope of production/consumption.
- Diversity and complexity of the production chain and industry.
- Potential for amplification of foodborne pathogens through the chain.
- Potential for control
- Extent of global trade and economic impact
- Level 1 priority globally (WHO/FAO)
Outbreaks / Illnesses USA 1990-2008

Source: Outbreak Alert! 2009 Updated Report
Greenhouse and fresh field tomato production

US 1990-2010

2003 North America (Mill. Ponds)

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<thead>
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<th>USA</th>
<th>Canada</th>
<th>Mexico</th>
<th>North America</th>
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</thead>
<tbody>
<tr>
<td>Greenhouse tomato</td>
<td>352</td>
<td>485</td>
<td>327</td>
<td>1,164</td>
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<tr>
<td>Greenhouse tomato imports</td>
<td>287</td>
<td>278</td>
<td></td>
<td>565</td>
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<td>Fresh field tomato</td>
<td>3,515</td>
<td>59</td>
<td>3,977</td>
<td>7,551</td>
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Tomato Outbreaks
1998-2008

- 32 in USA, 3456 illnesses and three deaths
- *Salmonella* spp., *Norovirus*, HAV
- No listeriosis so far
- Trace back to pre-harvest, field
- Pond water but mostly source data missing
- Risks in the greenhouse
Commodity Specific Food Safety Guidelines for the Fresh Tomato Supply Chain

2ND EDITION

Tomato GAPs

Open Field Production → Harvesting → Greenhouse Production

Field Packing or Packinghouse

Rепacking and Other Distribution Operations → Fresh-cut/Value Added Processing

Retail/Foodservice Processing/Preparation → Retail/Foodservice Outlet

Consumers
A Systems Approach to Managing Microbial Threats to Greenhouse Tomatoes-SCRI

Enteric pathogens

Lack of effective management strategies

Integrated system that simultaneously targets plant and human pathogens

Safe and high quality greenhouse tomato

Greenhouse industry growth
Objective 1:

Develop a system-wide framework to effectively manage introduction, spread and proliferation of plant and human pathogens

• Construct process flow for small, medium and large size ops

• Conduct risk assessment of identified practices for:
  • Clavibacter
  • Viruses/viroids
  • Botrytis
  • Salmonella spp.
  • E. coli
  • Listeria monocytogenes

• Test generated hypothesis for intervention in identified stages in which both human and plant pathogens can be targeted to reduce the risks

Objective 2. Develop rapid diagnostic technologies

Objective 3. Epidemiology of high priority tomato pathogens

Objective 4. Novel technology for integrated management of high priority pathogens
Identified & assessed 293 practices:
• Propagation 80
• Greenhouse production 159
• Post-harvest production 54

On-site visits (n=20)
Small 2
Medium 1
Large 4
Propagators 2
Greenhouse production (213)

- **Infrastructure**
  - Building: access, floors, gutters
  - Surroundings
  - Equipment: carts, clippers, trolleys

- **People flow**
  - Workers' hygiene and behavior: hand washing, footbaths, gloves, clothes
  - Workers' health policy

- **Propagation**

- **Media Preparation**
  - Transplanting
  - Training
  - Pruning & trussing
  - Harvesting
  - Leaning & lowering

- **Fertilizer preparation**

- **Irrigation**
  - Water cycle

- **Sanitation**

- **Pest management**

- **Post-harvest**

- **Waste Management**
Post-harvest production

Infrastructure
• Building
• Surroundings
• Equipment

Sanitation
• Workers’ hygiene and behavior
  - Hand washing, footbaths, hairnets, gloves, clothes
• Workers’ health policy

People flow

Packing materials

Cleaning/Washing

Weighing

Sorting

Transport

Storage

Packing

Quality control

Greenhouse

TOMATO

Waste Management
Operational Risk Assessment

Probability

<table>
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<th>Impact</th>
<th>Frequent</th>
<th>Likely</th>
<th>Occasional</th>
<th>Seldom</th>
<th>Unlikely</th>
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<tbody>
<tr>
<td>Catastrophic</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
<td>E</td>
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<tr>
<td>Critical</td>
<td>I</td>
<td>II</td>
<td>III</td>
<td>IV</td>
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<tr>
<td>Moderate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Negligible</td>
<td></td>
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Probability of plant disease and contamination with human pathogens

Greenhouse structure

Growing practices

Water management

Sanitation

Post-harvest practices

Food safety

Plant Disease
Greenhouse 5 - Large size

- Human pathogens
- Plant pathogens

Stage of production:
- Access
- Gutters
- Foothath
- Transplanting
- Growing medium
- Water source
- Water recycling
- Wounds
- Harvest
- Pest control
- Sanitation
- Worker’s health
- Packaging
- Washing/cleaning
- Transport

Frequently

Unlikely
Small size greenhouse: food safety

Stage of production

- Access
- Gutters
- Footbath
- Transplanting
- Growing medium
- Water source
- Water recycling
- Wounds
- Harvest
- Pest control
- Sanitation
- Worker's health
- Packaging
- Washing/cleaning
- Transport

Frequently

Unlikely
Small size greenhouse: plant disease

Unlikely

Frequently

Stage of production

Access
Gutters
Footbath
Transplanting
Growing medium
Water source
Water recycling
Wounds
Harvest
Pest control
Sanitation
Worker’s health
Packaging
Washing/cleaning
Transport
To follow:

- more on-site visits
- testing of generated hypothesis
- sampling of greenhouses to determine the effect of interventions
Conclusions:

• **Dynamic process flow** that takes into consideration the threats and current management practices for small, medium and large tomato greenhouse growers and propagators

• **Probability assessment** for each identified practice rather than generic guidelines

• **Growing practices to target simultaneous interventions:** plant handling during growing and harvest, water recycling, sanitation

• **Food safety** post-harvest interventions are required for small growers

• **Improved worker’s health policy would reduce risks for large producers**

• **Improved traceability for all**