Agenda

English Session (8:30 AM-10:30 AM; check-in 8:00 AM)
- Broomrape biology and risk of spread on equipment
- Overview of ongoing research on broomrape management in processing tomatoes
  - quaternary ammonia compounds
  - sanitation practices survey
  - critical sanitation control points on tomato harvest equipment
- Sanitizing surfaces: lessons from the food processing industry
  - demonstration
- Group discussion on developing and sharing equipment sanitation BMPs

Spanish Session (11:00 AM-12:00 noon; check-in 10:30 AM)
- Broomrape biology and risk of spread on equipment
- Sanitizing surfaces and critical sanitation control points on tomato harvest equipment
  - demonstration
- Group discussion and Q & A

Follow up questions? please email
Brad Hanson bhanson@ucdavis.edu, Cassandra Swett, clswett@ucdavis.edu, or Zach Bagley, zach@tomatonet.org

Hosted by:
Brad Hanson and Cassandra Swett, ANR CE Specialists, UC Davis
Zach Bagley, CTRI
Carlos Zatarain, Anterra Group, Inc.
Goal: Developing best management practices to prevent spread of broomrape and other soil borne pests on harvesters

Fusarium wilt, crown rots

Other soil borne diseases—southern blight, bacterial canker

Even nematodes!

Why harvesters?: Harvesters have the greatest debris and microbial loads

Debris loads

- Harvester
- Transplanter
- Trailer

Microbe loads

- Harvester
- Transplanter
- Tractor
- Vine diverter
Pressure wash alone was moderately effective in reducing debris loads. 

Debris loads

- **Cleaned Ave-Wash only**
- **Cleaned Ave-Wash+QAC**

<table>
<thead>
<tr>
<th>Equipment part</th>
<th>Rating</th>
</tr>
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<tbody>
<tr>
<td>Header sickle</td>
<td>1.0</td>
</tr>
<tr>
<td>Vine assist chain (header chain)</td>
<td>1.0</td>
</tr>
<tr>
<td>Dirt_Sort conveyor belt (pre dirt sort)</td>
<td>1.0</td>
</tr>
<tr>
<td>Fruit_Sort conveyor belt (pre fruit sort)</td>
<td>1.0</td>
</tr>
<tr>
<td>Shaker chain</td>
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</tr>
<tr>
<td>Suction fan (fan blades)</td>
<td>1.0</td>
</tr>
<tr>
<td>Duct (chute post fan)</td>
<td>1.0</td>
</tr>
<tr>
<td>Undercarriage bar-front axle</td>
<td>1.0</td>
</tr>
<tr>
<td>Undercarriage bar-rear axle</td>
<td>1.0</td>
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</tbody>
</table>

Thorough washing + sanitizer decreased both debris loads (above) and microbe loads (below).

**Fusarum**

After pressure wash + sanitizer
Accessibility = major barrier to effective cleaning

Accessible areas are typically effectively cleaned-belts and chains

Fusarium load
After pressure wash + sanitizer
Critical areas to improve sanitation: less accessible areas

Axle areas

Suction fan

Ducts

These critical control points are the primary focus on ongoing sanitation work.
What sanitizers?: Efficacy of different QACs in killing broomrape seed

Quaternary ammonium cations, also known as quats, are positively charged polyatomic ions of the structure NR+4, R being an alkyl group or an aryl group. Unlike the ammonium ion (NH+4) and the primary, secondary, or tertiary ammonium cations, the quaternary ammonium cations are permanently charged, independent of the pH of their solution. (source: Wikipedia)

Many commercial sanitizer products include a mix of several QAC (e.g. MG 4-Quat)

MG 4-Quat

Disinfectant - Sanitizer - Mildewstat - Virucide®
With Organic Soil Load For Industrial, Dairy, Equine, Poultry/Turkey Farms, Food Handling and Process Areas, Federally Inspected Meat and Poultry Plants and Sanitizing Ice Machines.

<table>
<thead>
<tr>
<th>ACTIVE INGREDIENTS:</th>
<th>TOTAL:</th>
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<tbody>
<tr>
<td>Alkyl (50% C14, 40% C12, 10% C16)</td>
<td>100.0%</td>
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<tr>
<td>Dimethyl Benzyl Ammonium Chloride</td>
<td>4.0%</td>
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<tr>
<td>Octyl Decyl Dimethyl Ammonium Chloride</td>
<td>3.0%</td>
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<tr>
<td>Didecyl Dimethyl Ammonium Chloride</td>
<td>1.5%</td>
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<tr>
<td>Dioctyl Dimethyl Ammonium Chloride</td>
<td>1.5%</td>
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<tr>
<td>OTHER INGREDIENTS:</td>
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</table>

KEEP OUT OF REACH OF CHILDREN
DANGER PELEIRGO
What affects sanitizer action?

Chemical(s)
Rate/dose
Exposure duration

Efficacy of sanitizers in reducing broomrape seed germination by 90%

Ammonium chloride not shown—highly ineffective

**ADAC**: Alkyl dimethyl ammonium chloride—**Most effective**

Unpublished QAC efficacy data on branched broomrape and Egyptian broomrape seed (*Hosseini, Osipitan, and Mesgaran. UC Davis*).

Research is currently ongoing to develop dose-response data for individual QAC as well as commercially-available mixtures on both broomrape seed and Fusarium at timescales relevant to sanitation of field equipment. Combined with harvester sanitation assay data, this information will help inform BMPs to help reduce spread of these pests on equipment.
Harvester Sanitation Best Management Guidelines (version 1.0)

WHERE TO CLEAN?

- A designated area for equipment cleaning, within the field perimeter, should be assigned and solely utilized.
- This area will be an at risk location for future broomrape emergence if there was seed in the debris removed from the equipment and should be monitored carefully in future crops.

CLEANING STEPS:

1. Remove loose debris –
   a. Soil and plant debris should be knocked off of all equipment using compressed air, scrapers, and pressure washers. Any visible plant or soil debris has some risk of containing broomrape seed or fungal spores.
   b. Pay particular attention to the areas that accumulate a lot of debris or are difficult to access.
      - Axles and frame members, suction fan, fan duct, and chipper are all areas that accumulate a lot of debris, are hard to clean, and are of high risk of moving seed or pathogens.
      - In high-risk fields, it may be necessary to remove the fan duct for thorough cleaning.

2. Pressure wash –
   a. Remove fine debris, caked-on plant and soil materials, and greasy areas that can harbor seed and pathogens and also inactivate chemical sanitizers.
   b. This is the most important step in the cleaning process. Areas that contain debris when the sanitizer is applied will not be sanitized, since debris deactivates the sanitizer.

3. Sanitize –
   a. AFTER CLEANING, apply chemical sanitizers which can kill broomrape seed and fungal or bacterial pathogens.
   b. Quaternary ammonium, NOT BLEACH, is the sanitizing agent which is proven to kill broomrape seed.
      - Locally this can be bought under the labels: Clorox Pro Quaternary, Chem quat, Flo San or MG 4-Quat.
      - A solution of at least 1% is necessary for efficacy and should be used to spray down the equipment after soil and plant debris has been knocked off and pressure washing is completed.
   c. Apply sanitizers to surfaces still wet from pressure washing, or rewet the surfaces before sanitizing to increase contact time and improve efficacy.

4. Do not rinse –
   a. To provide maximum activity on seed or pathogens, washed and sanitized equipment should be left to dry, not rinsed with water or other cleaning agents.

REMEMBER:

- If seed is underneath soil or plant material no cleaning agent, including quaternary ammonium, will be completely effective in killing seed or pathogens.
- No amount, or % of active ingredient, will make up for poorly-cleaned equipment with significant amounts of plant debris and soil. If you can see debris, there might be viable seed and pathogens in it even after applying a sanitizer.