Agricultural Water Quality & Testing Workshop

Connecting Produce Growers in Ohio with Water Testing Laboratories

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Water Quality Workshop

Part I: Agricultural Water, Sanja Ilic PhD 30 min
  • Production water quality, indicators
  • Preventing the risks
Part 2: FSMA revisions and requirements. Lindsey Hoover, OARDC 30 min

- Outline of the standard
- Proposed requirements for untreated surface water
- Establishing the baseline and water quality profile

Part 3: A to Z of water testing in a commercial lab, Gary Horrisberger

- Sampling procedures at the farm
- Sample storage and drop off
- In the lab: hands-on
- Get back in compliance
- Record keeping
Objectives

• Discuss the different uses for agricultural water
• Identify risks that impact the microbial safety of water sources
• Describe Indicators of contamination and importance of testing
• Risk Assessment: describe how application method and timing of water can impact crop contamination
• Risk Reduction: identify practices to reduce the potential for production water to contaminate produce
• Describe current water quality standards that are used to assess the microbial quality of water
Objectives

• Describe appropriate sampling procedures
• Describe storage, transport and drop off of water samples
• Describe the testing process in a commercial lab (microbiological tests, sample processing)
• Describe the options for getting back into compliance
Production vs. Post-harvest Water

Production: Agricultural water is used during produce growing activities for (other than sprouts) using a direct water application method

Direct contact with harvestable part of produce

- Irrigation
- Fertigation
- Crop sprays
- “Teas”
- Cooling

- Frost protection
- Dust abatement
- Crop establishment
- Other water uses
Post-harvest Water

Water that comes in direct contact with produce or food contact surfaces

Different standards!

- Commodity movement or cooling
  - (i.e. dump tanks/flumes)
- Ice
- Any postharvest application (fungicide, wax)
- Handwashing
- Cleaning and sanitizing
Agricultural Water Quality

- **Pathogen microorganisms** may be in water and contaminate produce.
- Many sources and uses of water on the farm.
- Many factors may impact the quality of water.
  - Application method, time
## Outbreaks 1998-2008

<table>
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<th>Produce Type</th>
<th>STEC. Coli</th>
<th>Norovirus</th>
<th>Salmonella</th>
<th>Hepatitis A</th>
<th>Cyclospora</th>
<th>Shigella</th>
<th>Total</th>
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<td>42</td>
<td>187</td>
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<td>0</td>
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<tr>
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<tr>
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<td>6</td>
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<tr>
<td>Peppers</td>
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<td>2</td>
<td>0</td>
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<td>10</td>
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<tr>
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<td>32</td>
<td>7</td>
<td>0</td>
<td>1</td>
<td>1</td>
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</tr>
<tr>
<td>Vegetable(s)</td>
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<td>20</td>
<td>7</td>
<td>3</td>
<td>0</td>
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<td>49</td>
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<tr>
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<td><strong>311</strong></td>
<td><strong>136</strong></td>
<td><strong>15</strong></td>
<td><strong>17</strong></td>
<td><strong>21</strong></td>
<td><strong>643</strong></td>
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Source: Scoping review data, Ilic 2011
Water Microbiology

• Organisms that are too small to be seen with the naked eye
  • Bacteria
  • Viruses
  • Parasites
Growth of Bacterial Cells

• Called “growth” or “multiplication”

• Under *the best* conditions
  a cell can divide every
  20 to 30 minutes
Multiplying Bacteria:
30 minute doubling time

- 8 a.m.  1 cell
- 9 a.m.  4 cells
- 10 a.m. 16 cells
- 11 a.m. 64 cells
- 12 p.m. 256 cells
- 1 p.m.  1024 cells
- 2 p.m.  4096 cells
- 3 p.m.  16,384 cells
- 4 p.m.  65,536 cells
- 5 p.m.  262,144 cells
- 6 p.m.  1,048,576 cells
Indicators:
Coliforms and generic *E. coli*
Coliforms

- Aerobic or facultative anaerobic, Gram-
- Non-spore forming rods

**A Non-fecal:** Soil, vegetation, insects

**B Fecal:** Human sewage and animal waste-septic systems, sewage spill, animal yards, run-off etc.

- Test media include lactose with dyes and/or surface-active agents
- Ferment lactose, forming acid and gas within 48 h at 35°C
- Fecal at 44.5 to 45.5°C
**E. coli**

• *E. coli* is both a coliform and a fecal coliform
• Found in the intestinal tract of warm-blooded animals

Traditionally *E. coli* was identified with the “++---” or “-+---” pattern in the IMViC test

“*I*” – produces Indol from tryptophan metabolism
“*M*” – ferments glucose to high acid, measured by Methyl Red
“*Vi*” – Vogues-Proskauer reaction (2,3 butaenidol/ acetoin from glucose)
“*C*” can use citrate as a sole source of carbon
Coliforms and *E. coli* as indicators

- In theory, indicator organisms signal the increased likelihood of pathogen presence
- Ex = presence of generic *E. coli* in water as an indicator of *Salmonella* contamination
- Numerous studies have determined that:
  - Indicator organism presence does not always mean presence of a pathogen
  - Indicator organism absence does not always mean absence of a pathogen
Coliforms and *E. coli* as indicators

- Use is most useful in an assessment of the overall quality of hygienic conditions present during production.
- *E. coli* is regarded as being the most valid indicator of fecal contamination of raw foods.
Sources of Contamination

- Agricultural run off
- Manure application
- Wildlife
- Waste water discharge
- Storm water
- Septic tank/ sewage
Susceptibility to Contamination

Lower Risk

Public Water Source

Treated

Ground

Protected

Higher Risk

Surface

Open to Environment

Curtesy of Dr. Betsy Bihn, Produce Safety Alliance
Understand your water source

- Source, distribution system
- Inspect the entire agricultural water system under your control, identify any conditions that are reasonably likely to introduce known or reasonably foreseeable hazards

- Assess surrounding areas, topography, water source, distribution methods, and animal activity (both wild and domestic)
- Can help reduce the chances that water sources become contaminated.
- Test water, establish baseline
Preventing Contamination of Surface Water Sources

• Assess nearby land use and upstream water activities to identify risks
  • Work with neighbors and local watershed groups to understand and minimize identified risks

• Assess run-off risks
  • Install berms or containments to minimize run-off from manure and compost piles, livestock feeding areas, or storm run-off

• Monitor and control animal access to irrigation water sources where practical (e.g. irrigation reservoirs)

Source: E. Bihn, G. Wall
Preventing Well Water Contamination

• Inspect well to ensure it is in good condition
• Inspect well head to ensure it is properly capped and elevated
• Be sure land slopes away from well head to prevent run-off contamination into the well
• Install backflow prevention devices

Source: E. Bihn, G. Wall
Preventing Public Water System Contamination

- Public water systems are treated to meet microbial drinking water standards, but if there is reason for concern:
  - Assess the delivery system downstream of the individual connection to the public water system
  - Test the water if you have any concerns

Source: E. Bihn, G. Wall
Less Contact with Water = Lower Risk

• If no contact the risk from water is reduced
• If there is direct contact of water with harvestable part of the produce the quality of the water and the timing of the application should be assessed
• Testing

Source: E. Bihn, G. Wall
Water Application and Timing

• If water *contacts the harvestable portion* of the crop, maximizing the time to harvest may reduce the risk

• Proposed **FSMA Produce Rule** outlines a microbial die-off rate of 0.5 log per day between the last irrigation event and harvest
  
  – *This will be important if your water does not meet standard criteria!*
Key Points

- Determine water source quality through testing
- If the water application method DOES NOT contact the harvestable portion of the crop, the risks are lower
- Extend time between application of water and harvest to reduce risks if water quality is a concern
  - Consider 0.5 log reduction per day
- Treating water is an option to reduce risks
Acknowledgements

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Dr. Betsy Bihn Cornell