Evaluation of Various Pathogen Remediation Strategies for Soil and Soilless Farming Systems in Anticipation of the New Food Safety Guidelines

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OBJECTIVE: Evaluate various pathogen reduction steps for soil and soilless farmers to consider when *E. coli* action thresholds are surpassed (non-contact irrigation water).

We utilized a hypothetical situation where the weekly water samples caused the rolling geometric mean to **EXCEED** acceptable levels.
7/7/14-Water testing results: *E. coli* 200 MPN/100 ML

6/11/14-Water test results: *E. coli* 130 MPN / 100 ML

5/9/14-Water testing results: *E. coli* at 310 MPN / 100 ML

**REMEDIAL ACTION: IMPLEMENT & EVALUATE VARIOUS PATHOGEN REDUCTION CORRECTIVE MEASURES**

BOD 5 day, EPA 405:1, MDL 1.0 mg/L: <1

Chemical Oxygen Demand: EPA 410:1, MDL 5.0 mg/L: 7.3

Total dissolved solids: EPA 160:1: MDL 1.0 mg/L: 36

**CHLORINE TREATMENTS: 200-400 ppm**

Scenario #1: Chlorine 200 ppm with 2 in line filters (120-175 micron) and 1 coffee filter (sand mimic filter)

Scenario #2: Chlorine 200 ppm with 2 in line filters
Scenario #3: Chlorine 400 ppm with 2 in line filters and 1 coffee filter

UV TREATMENT

Scenario #4: UV treated with 2 in line filters (120-175 micron)

AQUEOUS OZONE / UV TREATMENT

Scenario #5: Ozone treated with 2 in line filters (120-175 micron) FIRST then UV treatment

AQUEOUS OZONE TREATMENT: 1 HOUR UNIT

Scenario #6: Aqueous ozone mixed with irrigation water with 2 in line filters (120-175 micron)

PERACETIC ACID: 3 PPM

Scenario #7 Peracetic acid (OMRI APPROVED) shocked irrigation water with 2 in line filters (120-175 micron)
Summary:
We evaluated different corrective measures such as ozone, UV, chlorine and peracetic acid to reduce the microbial activity of *E.coli* in irrigation waters. We feel all remedial treatments evaluated hold promise for soil and soilless farming systems. Water quality issues need to be taken into account when implementing a remediation program. Remediated water should be re-tested before it is permissible to reinstate its use. If a single sample has *E. coli* levels greater than 576 MPN / 100 ML, the remedial treatment should be repeated. Do not utilize contaminated water or have it in contact with the edible portion of crops until corrective measures have been completed and generic *E. coli* levels are back within the acceptance criteria range (non-contact acceptable range below):

\[
\leq 126 \text{ MPN} / 100 \text{ mL} \quad \text{(rolling geometric mean n=5) and } \leq 576 \text{ MPN} / 100 \text{ mL for any single sample.}
\]

For specific information on treatment types or dosage options, please consult your local Extension agent or the HDOA food safety program.
OUR METHODOLOGY:

Irrigation water pumped into water containers with 2 inline filters. Used a 3rd coffee filter to mimic sand filter.

Calculated dosage and utilized chlorine strips, ORP and ATP meters to verify (and calibrate). Samples were submitted to the lab on the same day.

Aqueous ozone and UV system used.

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Samples tested via an independent laboratory, Hawaii Food and Water Testing.
REFERENCES:
Example SOP, Extracted from the Commodity Specific Food Safety Guidelines for the Production and Harvest of Lettuce and Leafy Greens

Figure 1B. Decision Tree for PRE-HARVEST WATER USE – Non-Foliar Applications whereby edible portions of the crop are NOT contacted by water (e.g. furrow or drip irrigation, dust abatement water)

For any given water source (municipal, well, reclaimed water, reservoir or other surface water):

**Sampling Frequency:** One sample per water source shall be collected and tested prior to use if >60 days since last test of the water source. Additional samples shall be collected no less than 18 hr apart and at least monthly during use.

- Sample sources as close to the point-of-use as practical using sampling methods as prescribed in Table 1.
- Analyze samples for generic E. coli using a FDA BAM method or any other EPA-approved or AOAC-accredited method may be used.
- Geometric means, including rolling geometric means shall be calculated using the five most recent samples.

**Acceptance Criteria**

\[ \leq 126 \text{ MPN/100ml} \]

*(geometric mean of 5 samples)*

AND

\[ \leq 576 \text{ MPN/100ml (all single samples)} \]

No further action necessary. Water from this source may be used for any agricultural production use where direct contact with edible portions of the crop does not occur. However, when test results are higher than normal or indicate an upward trend, investigation and/or remedial action SHOULD be taken.

**Action Level**

\[ > 126 \text{ MPN/100ml} \]

*(geometric mean over five samples)*

**OR**

\[ > 576 \text{ MPN/100ml (any single sample)} \]

**Remedial Actions:**

- Discontinue any agricultural production use until it returned to compliance.
- Examine the water source and distribution system to determine if a contamination source is evident and can be eliminated.
- For wells, perform a sanitary survey and/or treat as described in Appendix A Sanitary Survey.
- After sanitary survey and/or remedial actions have been taken, retest the water at the same sampling point.
- Continue testing daily for five days at the point closest to use.
- If any of the next five samples is \( > 576 \text{ MPN/100ml} \), repeat sanitary survey and/or remedial action.
- Do not use this water system until the water can meet the outlined acceptance criteria for this use.

**Crop Testing:**

- If water exceeding the acceptance criteria has been used for crop production, sample and test product for *E. coli* O157 H7 and *Salmonella* as described in Appendix C, prior to harvest.
- If crop testing indicates the presence of either pathogen, do NOT harvest for human consumption.
Calculating Rolling Geometric Means

Water Requirements in the Proposed Produce Safety Rule of the Food Safety Modernization Act

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Figure 2. Agricultural Water – What is a Rolling Geometric Mean?