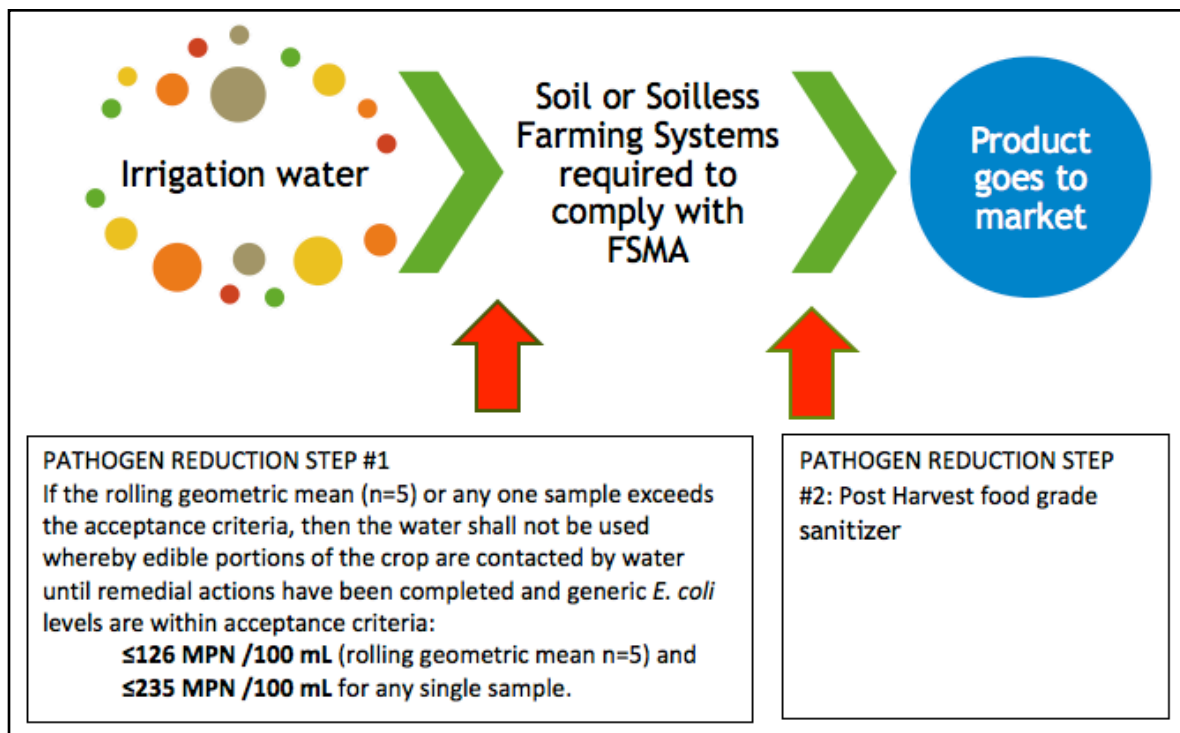


## Evaluation of Various Pathogen Remediation Strategies for Soil and Soil-less Farming Systems in Anticipation of the New Food Safety Guidelines

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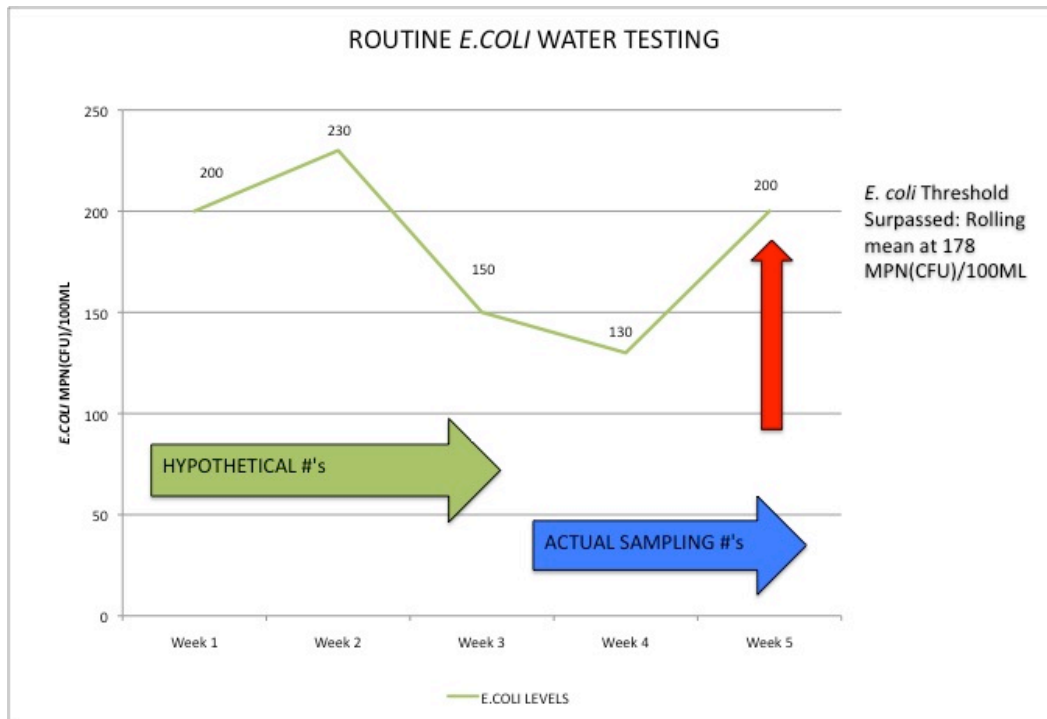
Agriculture water is a major risk factor for the contamination of fresh produce. If untreated, agriculture water has the potential to carry many different human pathogens such as *E. coli*, *Salmonella*, and *Shigella*. Many soil and soilless farming systems use untreated irrigation water, whether it's from a ditch, reservoir, or effluent water produced in aquaponics systems. The use of untreated irrigation water will become a challenge for most farming systems as food safety standards will become stricter with the release of the new Food Safety Modernization Act (FSMA) by the Food and Drug Administration (FDA). Currently the FDA is proposing that when water is used during growing activities, that water must meet the proposed water quality standards. These standards are 1) geometric mean of <126 colony-forming units (CFU)/100 ml of generic *E. coli* based on five consecutive samples, or 2) <235 CFU/100 ml of generic *E. coli* for any single water sample (FDA, 2014). Once a farming system detects excessive levels of generic *E. coli* they must discontinue use of the contaminated water and implement a corrective action to remediate the water and bring it back to an acceptable level.



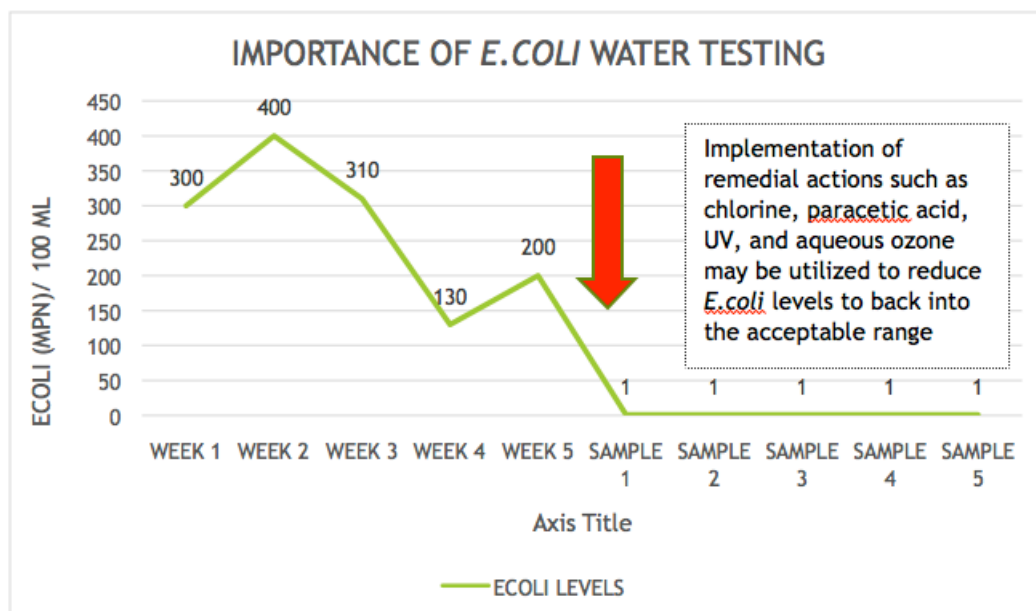
In May of 2014 we conducted a trial to evaluate various pathogen reduction steps for soil and soilless farmers to consider when *E. coli* action thresholds are surpassed. We utilized a hypothetical situation where the weekly water samples caused rolling geometric means to exceed acceptable levels. Initial water samples results were 200, 230, 150, 130 and 200 CFU/100mL for weeks 1-5 respectively (Figure 1). This resulted in a rolling mean of 165 CFU/100mL, which is above the *E. coli* threshold of 126 CFU/100mL. Five different pathogen reduction methods were selected, which include chlorine, UV, aqueous ozone and UV, Aqueous ozone alone and

paracetic acid. These methods were used to treat irrigation water collected. Samples were tested using portable ORP and ATP meters and then sent to the Hawaii Food and Water for microbial testing.

Figure 1



Our data suggest that all measures for treating irrigation water has the potential to reduce microbial activity in irrigation water to acceptable levels. In treatments receiving chlorine pH increased from 7.4 to 9.2-9.7. This increase in pH could have an adverse effect on plant growth as many plant nutrients become unavailable at that pH.



## 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.

### 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



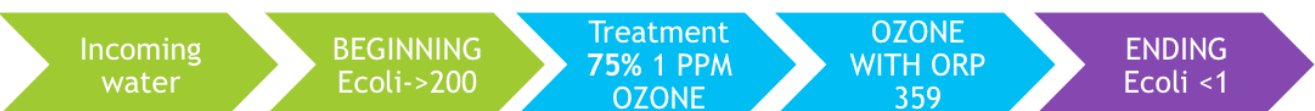
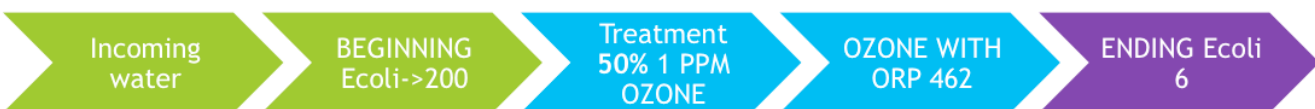
### AQUEOUS OZONE TREATMENT: 1 HOUR UNIT

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

BOD 5 day, EPA 405:1, MDL 1.0 mg/L: 2.5

Chemical Oxygen Demand: EPA 410:1, MDL 5.0 mg/L: 7.5

Total dissolved solids: EPA 160:1: MDL 1.0 mg/L: 68



### PARACETIC 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):

**≤126 MPN /100 mL** (rolling geometric mean n=5) and  
**≤235 MPN /100 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.

## Acknowledgements

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Samples tested via an independent laboratory, Hawaii Food and Water Testing.

## References

FDA. 2014. Standards for the Growing, Harvesting, Packing, and Holding of Produce for Human Consumption.

Example SOP, Extracted from the Commodity Specific Food Safety Guidelines for the Production and Harvest of Lettuce and Leafy Greens.

*Article content is the sole responsibility of the author. For more information about this article, contact Jensen Uyeda, email: [juyeda@hawaii.edu](mailto:juyeda@hawaii.edu).*