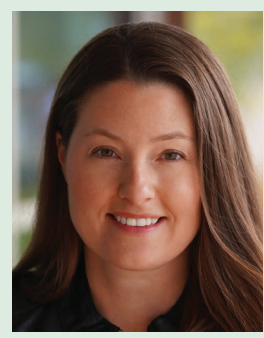


Microbiological risk assessment using QMRA in preharvest agriculture water treatment systems for leafy greens



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Summary

While much research has been done on efficacy of commonly used agricultural water treatment sanitizers including peroxyacetic acid (PAA), calcium/sodium hypochlorite, and chlorine dioxide to reduce pathogens/indicators in water, little research has focused on the potential added benefit of these sanitizers on pathogens that are already established on crop surface/plant tissue or in soil. Additionally, variability in water treatment or “breakthrough” has also not been properly characterized in an agricultural setting. This project aims to directly address these knowledge gaps by using laboratory and field evaluation coupled with quantitative microbial risk assessment (QMRA) (Figure 1). Ultimately, the study will provide growers and regulators with an improved understanding of the impact of water treatment on risk reduction for consumers.

Objectives

1. Determine the die-off or log-reduction of Shiga-toxigenic *E. coli* (STEC) and generic *E. coli* surrogates pre-established on leaf surfaces and in soil following agricultural water treatment with commonly used water treatment sanitizers (PAA and calcium hypochlorite).
2. Conduct in-field evaluations of water treatment variability or “breakthrough” using traditional grab sampling techniques for microbiological indicators (generic *E. coli* and total coliform bacteria) coupled with real-time in-line monitoring for various physical and chemical parameters.
3. Use real-world collected data from research Objectives 1 and 2 to conduct a QMRA for STEC in leafy greens (romaine and spinach).

Methods

The research team aimed to determine the log-reduction of STEC and generic *E. coli* surrogates pre-established on leaf surfaces and in soil following agricultural water treatment with PAA and calcium hypochlorite. Replicate fields trials mimicking contamination events in both Maricopa and Yuma, AZ, were conducted. During these events, samples of soil, plant tissue, and irrigation water were collected. To date, the research and extension team have collected and analyzed 2,298 samples towards the goals and objectives of this project.

The team also conducted evaluation of water treatment variability or “breakthrough” (Figures 2 and 3) using traditional grab sampling techniques for microbiological indicators (generic *E. coli* and total coliform bacteria) coupled with real-time in-line monitoring for physical and chemical parameters (Figure 4).

Results to Date

Field data collected to date demonstrates the variable impact of agricultural water treatment on bacterial die-off and persistence, and support previous findings indicating there is indeed beneficial impact of water treatment beyond reduction of microorganisms in irrigation water alone. One interesting finding that was not anticipated is that there may be enhanced survival or protection of contaminants that enter a field through animal intrusion or “scat” as opposed to those contaminants that enter a field through a failed water treatment or pesticide spray application. This has implications for how the data is fed into the QMRA as well as suggested outcomes for industry.

Benefits to the Industry

This project will provide the produce industry with scientific data related to the cumulative benefits and tradeoffs of agricultural water treatment on human health risk. Because so few QMRAs have been conducted on an agricultural field setting with site-specific information rather than relying on literature assumptions, we believe this information is critical to inform grower and regulator decision-making related to the use of agricultural water treatment as an effective mitigation measure. Data from this project will be used to inform industry participants of the most effective strategies towards treatment performance to meet FDA Subpart E and LGMA metrics requirements as well as to minimize the risk of produce contamination by foodborne pathogens, which could be present in irrigation waters, on plant surface, or in soil.

Figure 1. Overview of Stochastic QMRA Model

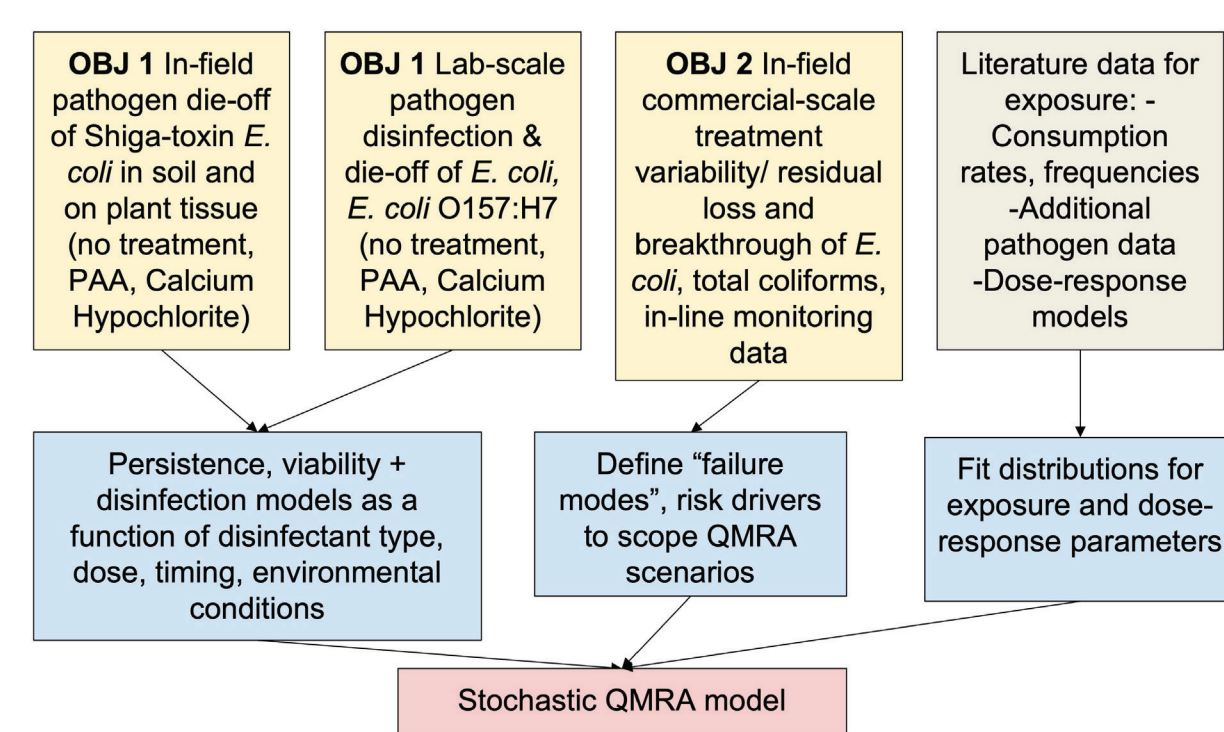


Figure 2. Water Treatment Variability (First Sprinkler Head)

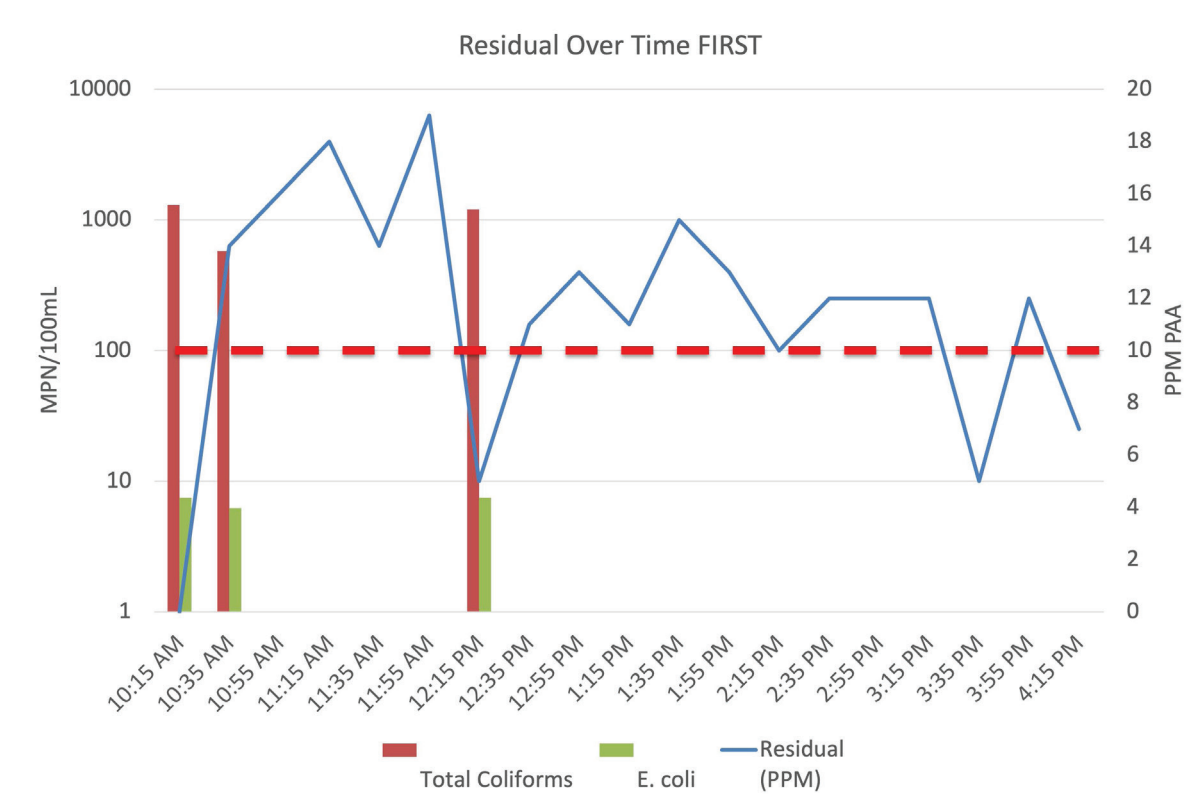


Figure 3. Water Treatment Variability (Last Sprinkler Head)

