RESEARCH IN PROCESS

Scientifically valid corrective actions for multiple harvest shade-house production systems

SUMMARY

From 1996 to 2016, multiple outbreaks associated with consumption of shade-house or greenhouse grown produce were reported. Environmental investigations underscored the need for science-based practices to prevent or respond to detected contamination on multiple-harvest crops produced in protected culture systems. Pathogen detection typically results in destruction of the remaining crop; however, a knowledge-based foundation for pathogen die-off and systematic sampling regimes has broad industry support. At this time, there is very sparse science-based guidance for assessing the risk of contamination of fresh produce grown under protected culture. Closing this knowledge gap is critical to decision-making and application of valid corrective actions following pathogen detection in product or environmental samples. Our specific goal is the assessment of die-off expectations for bacterial pathogens and assessment of corrective action options for shade-house grown crops. We will evaluate measures to minimize the risk of transference and persistence of bacterial pathogens in the shade-house culture.

OBJECTIVES

1. Determine the die-off kinetics of *E. coli*, EHEC, *Salmonella*, and indicator *Listeria*, in controlled research protected culture, on cucumber, roma-type tomato, and jalapeño peppers following simulated leaf and fruit contamination from irrigation and soil surface and other shade-house environmental sources, including trellising and harvest activities.
2. Comparatively evaluate methods, sampling protocols, sample processing protocols, and sensitivity of detection of bacterial pathogens in preharvest testing designed for shade-house EMPs.
3. Evaluate the efficacy of various corrective actions to minimize the risk of transference and minimize persistence of bacterial pathogens within and on the standing crop.

METHODS

Antibiotic-marked isolates of nonpathogenic/avirulent surrogates (*E. coli, E. coli* O157:H7, attenuated *Salmonella*, *Listeria innocua*) will be applied to trellised cucumber, low-trellis/staked roma-type tomatoes and jalapeño peppers in high tunnel hoop-house structures (20'W by 24'L) and open-field plots (Fig. 1). Quantitative and qualitative survival will be assessed at 1, 3, 5, and 8 days on inoculated fruit, leaves. Boot swabs, after each trellising and harvest event, will be processed for qualitative detection of applied surrogates.

Corrective actions to minimize contaminant persistence and transference include fruit stripping (1 to 3 tiers of maturity) and at least three commercially registered antimicrobial formulations. Fruit spot inoculation and immersion inoculation (Fig. 2) and pathogen recovery will be used to reconstruct presumptive conditions contributing to the potential contamination in distribution: for example, transfer from soil, drip lines, early season fruit imperfections, harvest totes, handling and wash-line injury, waxing, shipping bags, and condensation during temperature shifts.

RESULTS TO DATE

To date, field location has been granted and field preparation took place in mid-April. For field description see Figure 1. This year's experimental trials will be initiated once plants are ready for transplanting, followed by fruit inoculation prior to fruit harvest maturity.

BENEFITS TO THE INDUSTRY

Our overall goal is to take a systems approach to (1) Re-construct the root-cause(s) and antecedents of outbreaks associated with shade-house grown crops; (2) Develop a set of situation-appropriate corrective actions to the detection of pathogens; and (3) Establish data-based standards for environmental monitoring of shade-house crops. Our performance measure is a detailed publication describing potential predisposing and interacting preharvest and postharvest root-cause(s) of a serious outbreak attributed to cucumber. Our benchmarks will be an array of at least four sampling, monitoring, verification, and corrective action options for producers of shade-house grown crops to prevent marketing of contaminated crops and limit economic losses by minimizing crop destruction through validated sampling plans. We anticipate that this corrective action decision index system will be extended to other produce applications and growing regions. Our target is a major change in preventive controls among shade-house growers and shippers.

Dip and Spot Inoculation Results

Log CFU/Cucumber ± st dev *																
Inoculum type	Storage Temp	n	0 DPI				2 DPI					6 DPI				
Dip Inoculation	10 °C	3	1.30 ± 0.00				A	nd				0.59 ± 0.03			B	
	15 °C	3					AB	0.85 ± 0.27			B	2.00 ± 0.63			A	
	20 °C	3					A	1.04 ± 0.38			A	1.39 ± 0.97			A	
	29 °C€	3					A	1.47 ± 0.34			A	1.77 ± 0.50			A	

Log CFU/Cucumber ± st dev *																
Inoculum type	Storage Temp	n	0 DPI				1 DPI					6 DPI				
Spot Inoculation	29 °C	3	1.29 ± 0.03				AB	0.82 ± 0.42			B	1.68 ± 0.26			A	

DPI: Day(s) Post Inoculation

*Letter scores represent statistically significant differences between DPI at P < 0.05 per holding temperature

Limit of detection: log 0.56 CFU/cucumber

€: For 6 DPI at 29°C n=4

Cucumber crop destruction

After drying, coated with Decco Veg Lustr 227F

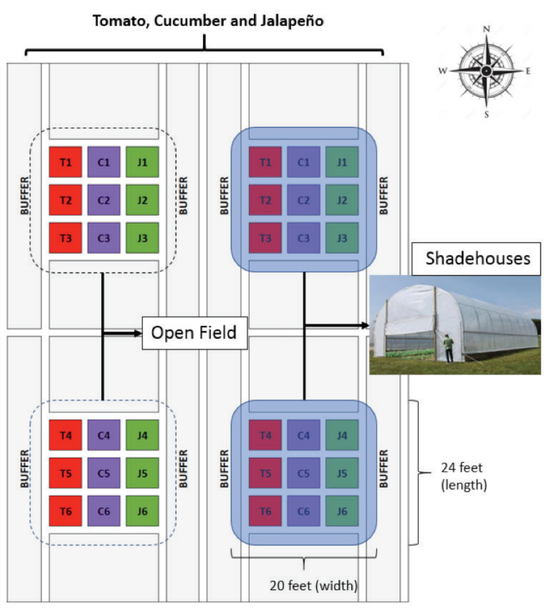

Figure 1. Set-up for open field and shade-house trials at UC Davis field research facility.

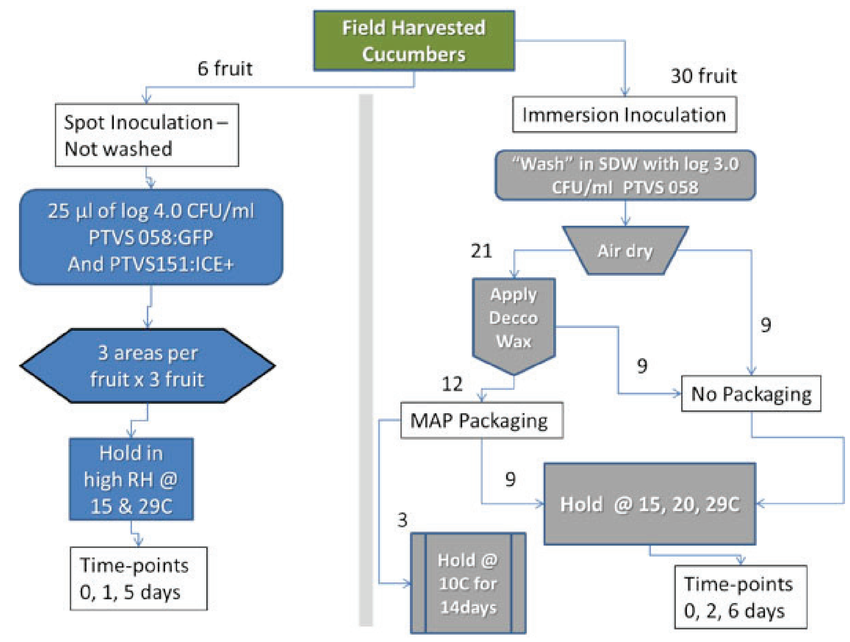

Figure 2. Example of cucumber postharvest risk assessment process flow. Numbers by connector arrows follow the path of replicated fruit. Experiments with different sanitizers, seasonal harvests, and different brush-waxer stiffness will be repeated at least three times.

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