Funding Science • Finding Solutions • Fuel the Change

Why Guess?
Fill Knowledge Gaps With New Insights from Field-based Research

August 1, 2019
10:00am Pacific Standard Time

CPS CENTER for PRODUCE SAFETY

Webinar Instructions

Attendees will be on mute during the webinar

Please send questions through chat box

Connection questions may be directed to: info@centerforproducesafety.org

CENTER for PRODUCE SAFETY

Speakers

Dave Corsi

VP of Produce and Floral at Wegmans Food Markets

Chair, Center for Produce Safety Board of Directors

Dr. Channah Rock,

Professor and Water Quality Extension Specialist

University of Arizona

Dr. Trevor Suslow,

Emeritus Extension Faculty, UC Davis

Vice President, Produce Safety, Produce Marketing Association

Bonnie Fernandez-Fenaroli

Executive Director, Center for Produce Safety

Welcome

Dave Corsi
VP of Produce and Floral
Wegmans Food Markets
&
Chair, Center for Produce Safety
Board of Directors

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Mission:

Fund the science, find solutions and fuel the change

Purpose:

Providing the science to support produce safety

Rapid Response Research

- Research opportunities that will be lost if not implemented quickly
- Industry partner require
- Maximum Project Cost - $50,000 – maybe larger if cash match is available
- CPS funds available – Will provide up to 50% of total project cost as a match to other cash pledges.
- Proposal and Budget must be submitted at the same time.
- Once the proposal and budget is received. A subcommittee of the CPS Technical Committee is formed. A review will be provided within 3-5 days of the proposal receipt.
- The receiving university must be ready to implement a contract quickly.

Dr. Channah Rock
Professor and
Water Quality Extension Specialist
University of Arizona

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CPS Rapid Response – Yuma Valley Objectives

- To capitalize on the unique opportunity to study romaine production under real world conditions within close proximity to potentially implicated fields from the 2018 outbreak

- To generate new knowledge that is useful to industry in order to bridge the gap created by the recent outbreak

Scope Of Work

1. **Water treatment**

2. Persistence of microbial contamination on Romaine after **freeze injury**

3. Industry sampling protocols and pathogen transport through **commercial scale harvest**

Industry Support

- Two 3 acre plots
- Three varieties of Romaine
  - *Del Sol, Sunbelt, 8403*
- Furrow and Sprinkler Irrigation*
- Commercial Scale Harvester/Crew
- Staff time/resources

*same canal water source

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1. Water Treatment

- Peroxyacetic Acid (PAA)
  - 2 to 6 ppm target concentration*
- 12% Sodium Hypochlorite (NaOCl)
  - 3 to 5 ppm target concentration*

** industry "standard"*

Water Treatment

- Triplicate trials of each sanitizer
- Positive control field plots (3)
- Spiking Strain
  - TVS353 (ECC ChromAgar + 80ug/ml rif)
  - Isolated from Irrigation Water
  - 10^2 to 10^4 CFU Target Concentration

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Water Treatment

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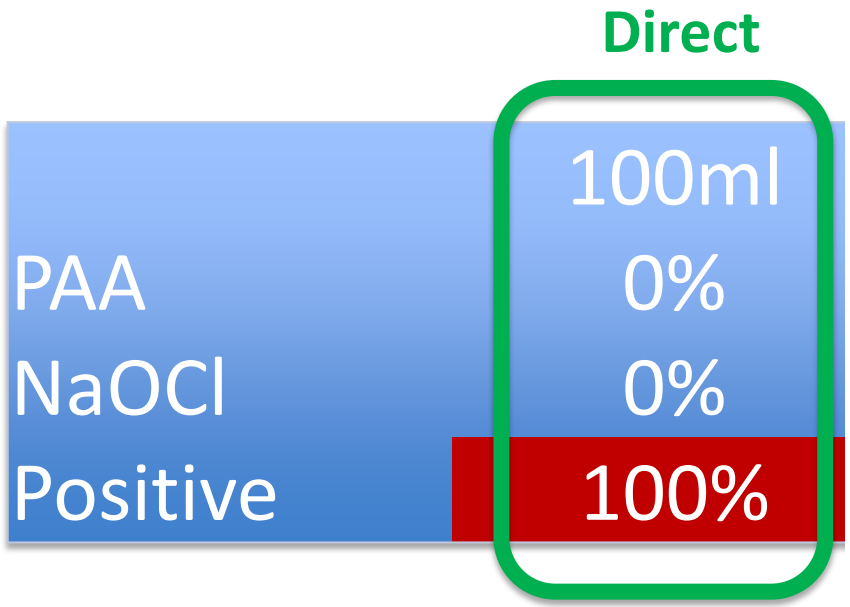
Water Treatment

- Sample Types
  - Irrigation Water
    - Grab Samples (birds), mMS filters
    - Calculate log reductions
  - Plant Tissue
    - Industry protocols, ‘S’ and ‘Z’ (n=60+)
    - Presence/Absence
  - Soil
    - Grab/Composite samples
    - Presence/Absence

Irrigation Water

Concentration (CFU)	492
Detection Limit	1
Log Reduction	2.69

- 1st and last sprinkler head
  - Log reduction ><u>**2.69**</u> for both PAA <u>**and**</u> NaOCl*



*day of treatment, not pH adjusted

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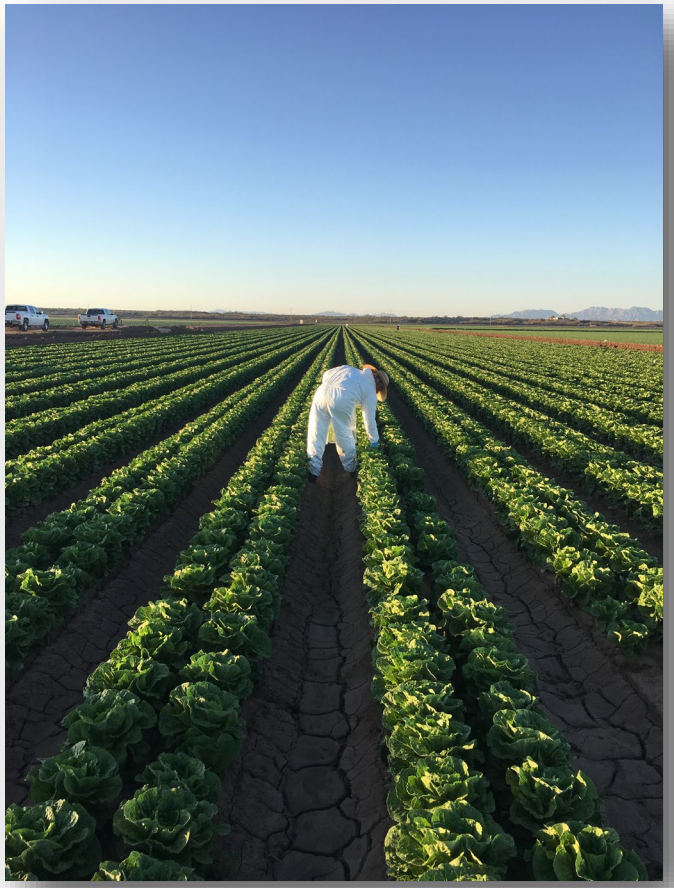
Plant Tissue

- **PAA**
  - "S" pattern = 50% positive
  - "Z" pattern = 25% positive
- **Sodium Hypochlorite**
  - "S" pattern = 0% positive
  - "Z" pattern = 0% positive
- **Positive Control**
  - "S" pattern = 100%
  - "Z" pattern = 96%



*7 days after treatment

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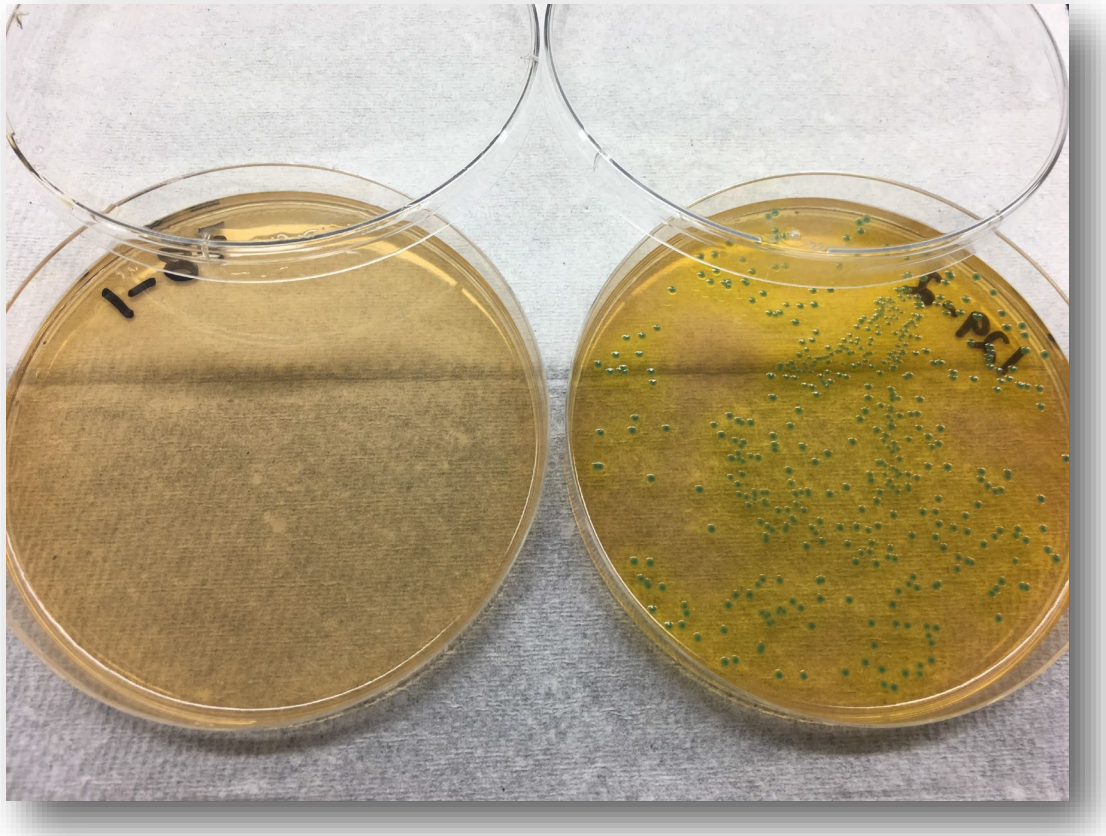
Soil

- **PAA**
  - Zones 1-5 (66% positive)
- **Sodium Hypochlorite**
  - Zones 1-5 (33% positive)
- **Positive Control**
  - Zones 1-5 (66% positive)



*7 days after treatment

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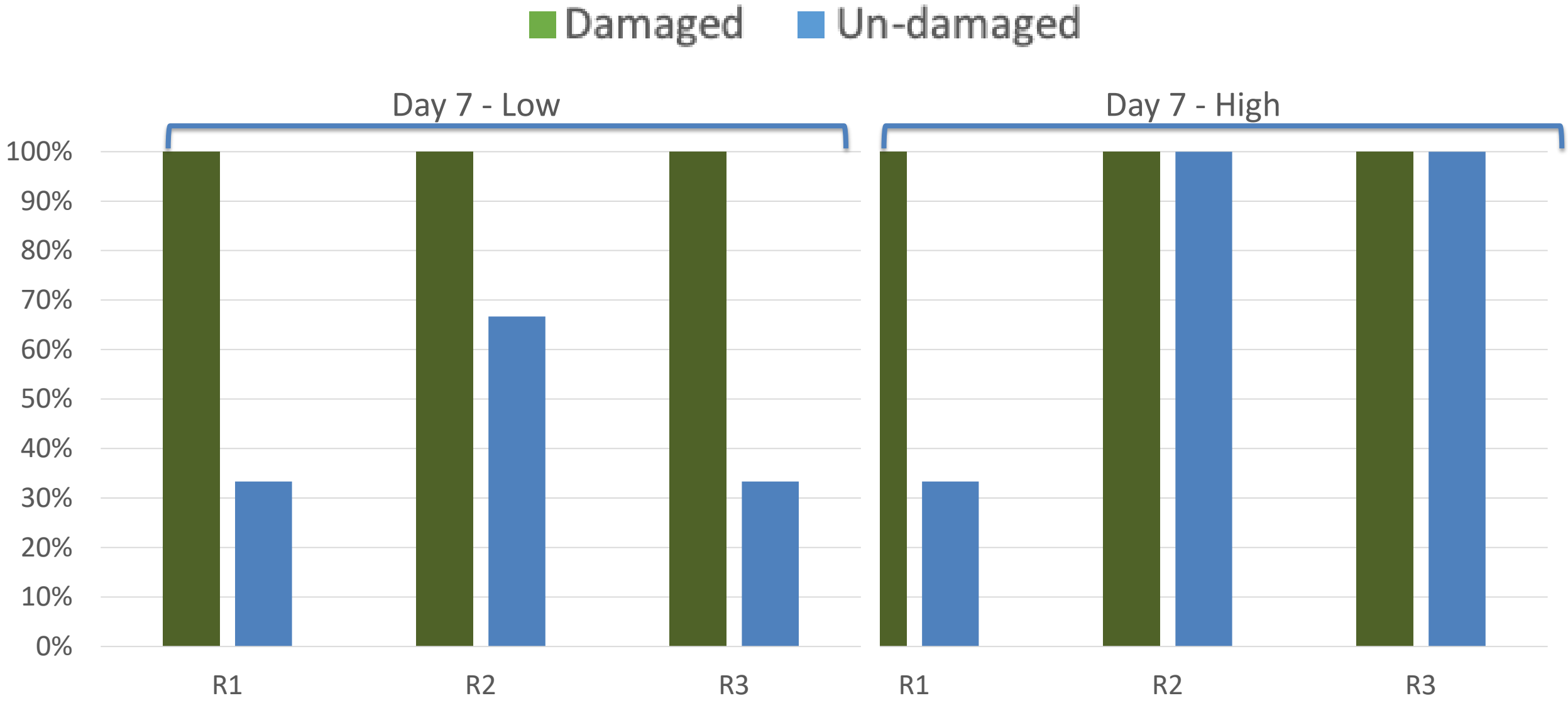
2. Freeze Damage

"What is the impact of freeze damage on harborage of bacteria?"

Freeze Damage



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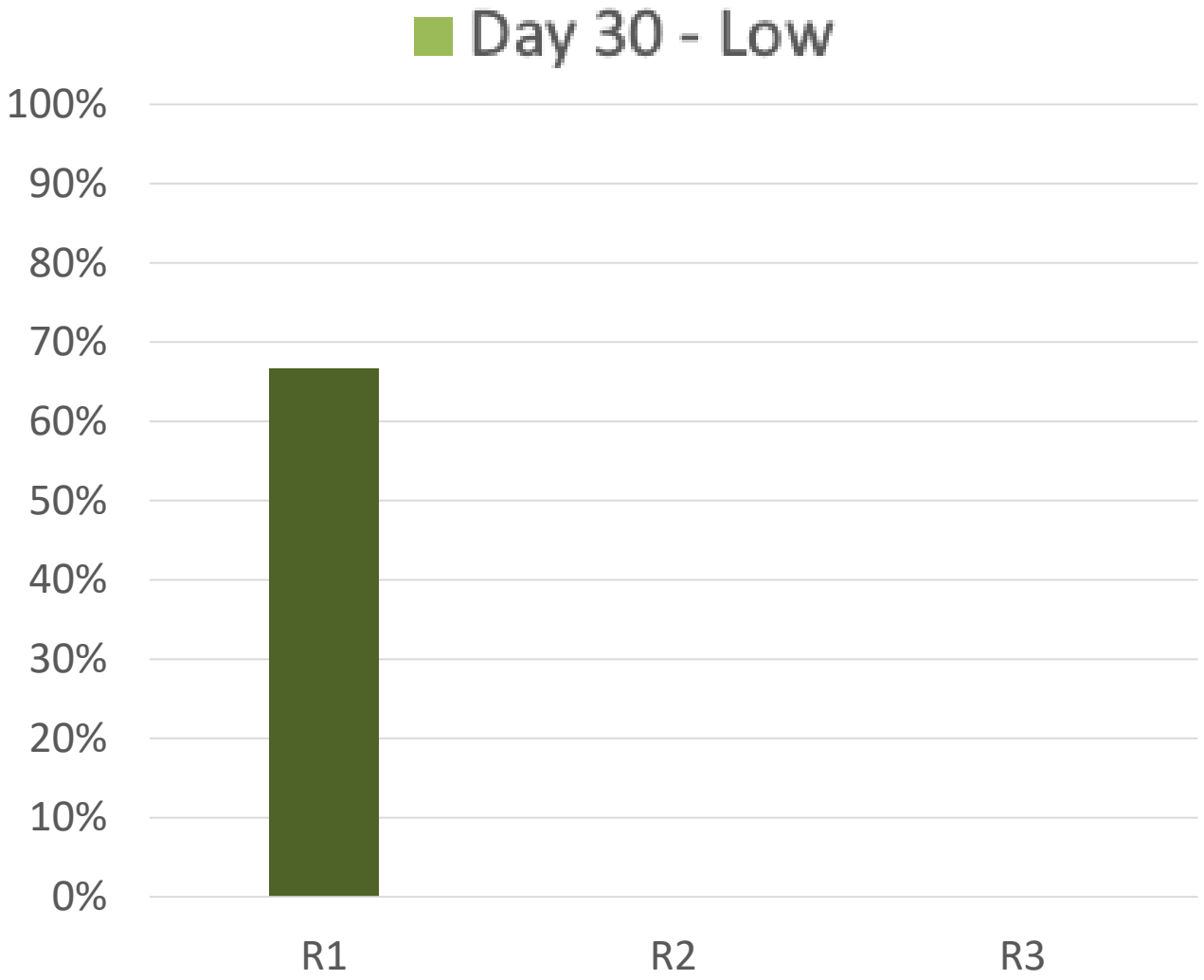
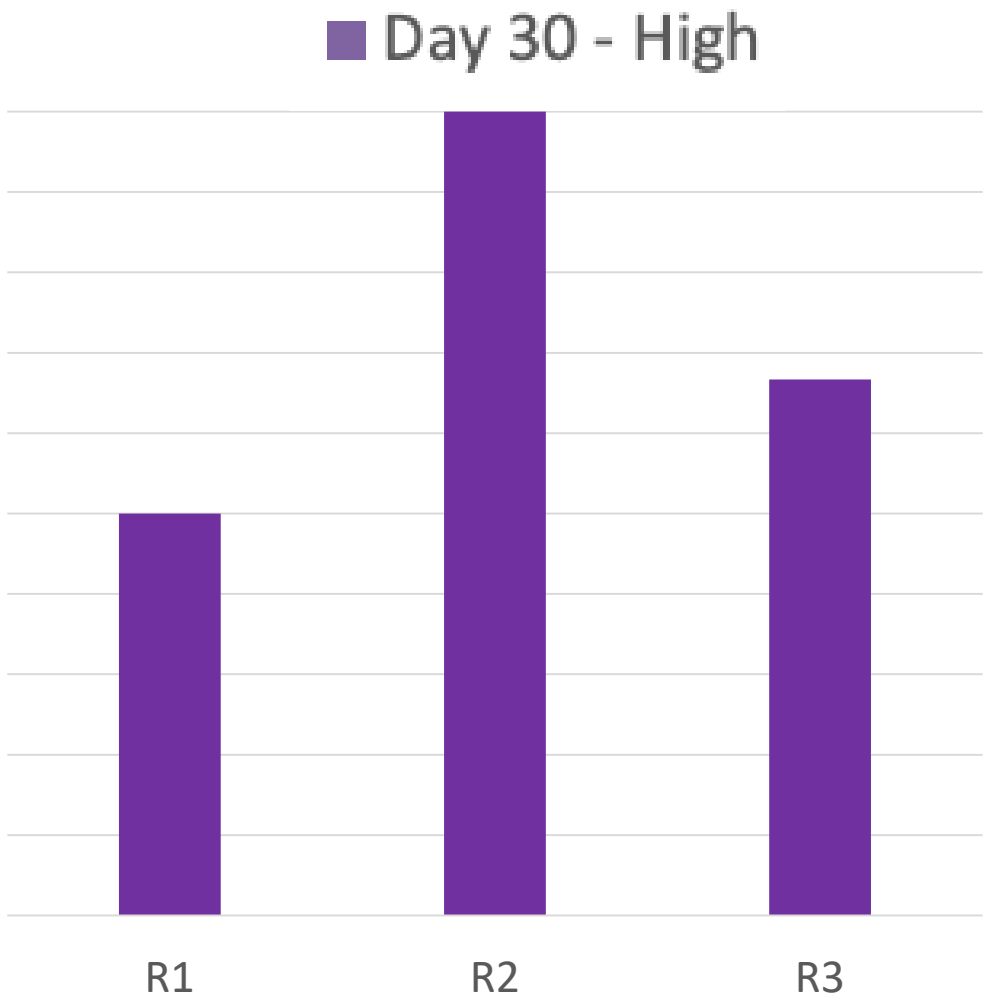
Freeze Damage





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3. Field Contamination/Harvest

- Three “Contamination” Event Types

    1. Contamination “Pulse” Furrow Irrigation
    2. Animal Intrusion
    3. Aerial Application

Contamination “Pulse” Furrow Irrigation

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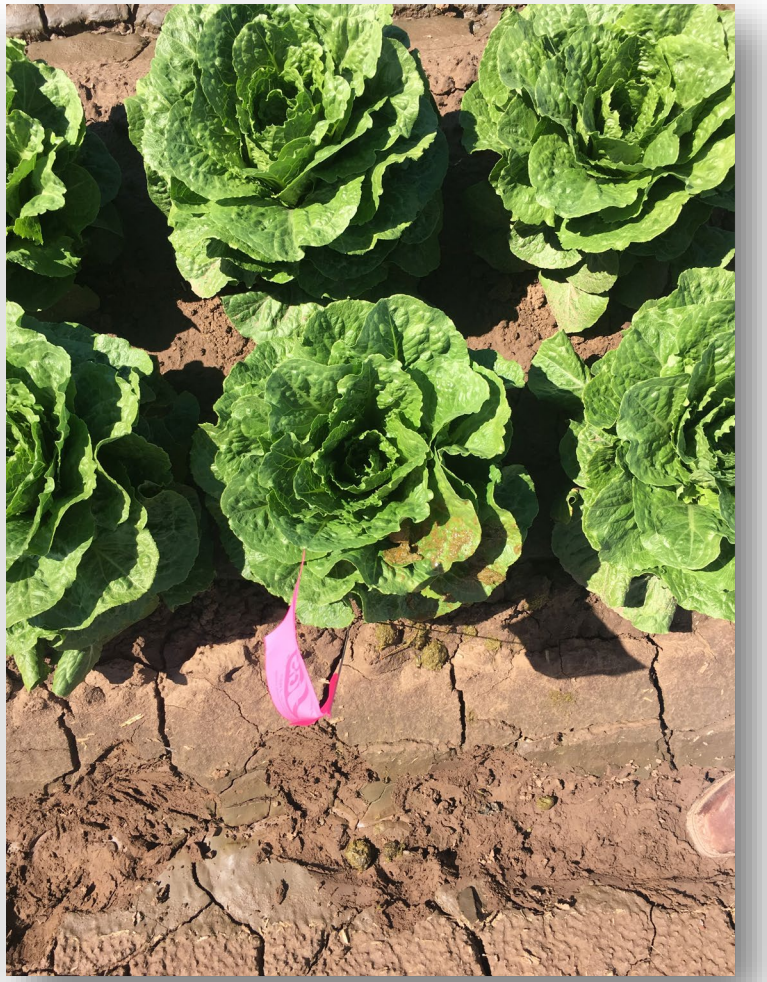
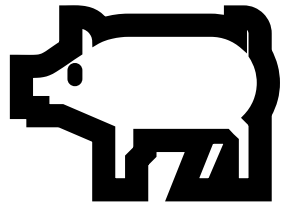
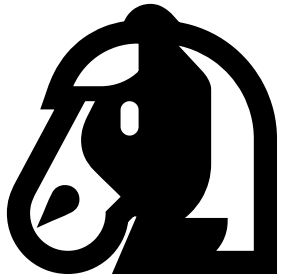
Animal Intrusion





= pig



=

horse

= goat

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Aerial Application

- Mimic pesticide application
- Known/measured application rates
- Highly controlled

3. Field Contamination/Harvest

- Sample type
  - Raw Product pre-harvest (field)
  - Workers gloves (swabs)
  - Harvest tools (swabs)
  - Table surface (swabs)
  - Conveyer belt (swabs)
  - Elevator (swabs)
  - Raw Product post-harvest (disposable bins)

Commercial Scale Harvester

- 40+ person crew
- 9 harvesting “stations”

Commercial Scale Harvester

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Commercial Scale Harvester

Raw Product Pre-Harvest

Furrow Irrigation	Animal Intrusion	Aerial Application
Z= ✅	Z= 🚫	Z= ✅
S= 🚫	S= 🚫	S= ✅

Bin 4

Bin 3

Bin 2

Bin 1

Bin

Table

Animal Intrusion

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Furrow Irrigation

	Stop 1	Stop 2	Stop 3	Stop 4	Stop 5
Gloves	0%	20%	0%	0%	0%
Knife	0%	20%	20%	0%	0%
Table	0%	20%	0%	0%	0%
Belt	0%	0%	0%	0%	0%
Elevator	0%	0%	0%	0%	0%

Animal Intrusion

	Stop 1	Stop 2	Stop 3	Stop 4	Stop 5
Gloves	0%	40%	60%	40%	40%
Knife	0%	40%	60%	0%	20%
Table	0%	60%	80%	60%	60%
Belt	0%	20%	0%	0%	0%
Elevator	0%	100%	100%	100%	100%

Aerial Application

	Stop 1	Stop 2	Stop 3	Stop 4	Stop 5
Gloves	0%	80%	80%	80%	100%
Knife	0%	80%	80%	80%	80%
Table	0%	80%	80%	80%	80%
Belt	0%	100%	80%	80%	0%
Elevator	0%	100%	100%	100%	100%

Raw Product Post-Harvest Bins

Furrow Irrigation	Animal Intrusion	Aerial Application
Bin 1= 🚫	Bin 1= ✅	Bin 1= ✅
Bin 2= 🚫	Bin 2= ✅	Bin 2= ✅
Bin 3= 🚫	Bin 3= 🚫	Bin 3= ✅
Bin 4= 🚫	Bin 4= ✅	Bin 4= ✅

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What we learned…

- Sanitizers were effective at reducing microbial loading in irrigation water
- Bacteria may survive water treatment and persist in soil and on plant surface
- Sample volume matters!

What we learned…

- At high concentrations, bacteria were able survive on “freeze-damaged” romaine
- Variety type had minimal impact
- At lower concentrations, “freeze damaged” romaine may have the ability to harbor bacteria extended periods of time

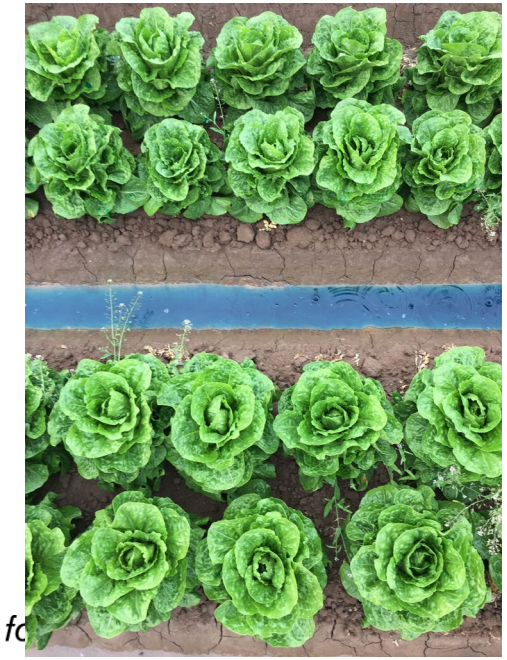
What we learned…

- Pre-harvest sampling protocols on 1 acre plots detected contamination, but **post harvest sampling was more consistent**
- Contamination by furrow irrigation was detectable through harvest
- Harvest practices aid in contamination transfer
- Animal Intrusion and Aerial Application contamination events result in pervasive contamination

Getting the work done!

- 50+ UA Students and Staff
- Industry Support!!
- Initiated field work Feb. 18th
- 3 straight weeks in field
- Complete lab work (culture)

  April 8th
- Molecular work on-going
- 2000+ Samples



Dr. Trevor Suslow
Emeritus Extension Faculty,
UC Davis
&
VP Produce Safety
Produce Marketing Association

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UC DAVIS Field Demonstration Trials 2019

- Bioaerosol survival & head distribution
- Furrow irrigation cross-contamination risk

Dr. Trevor Suslow Emeritus Extension Faculty, UC Davis and VP Produce Safety, PMA

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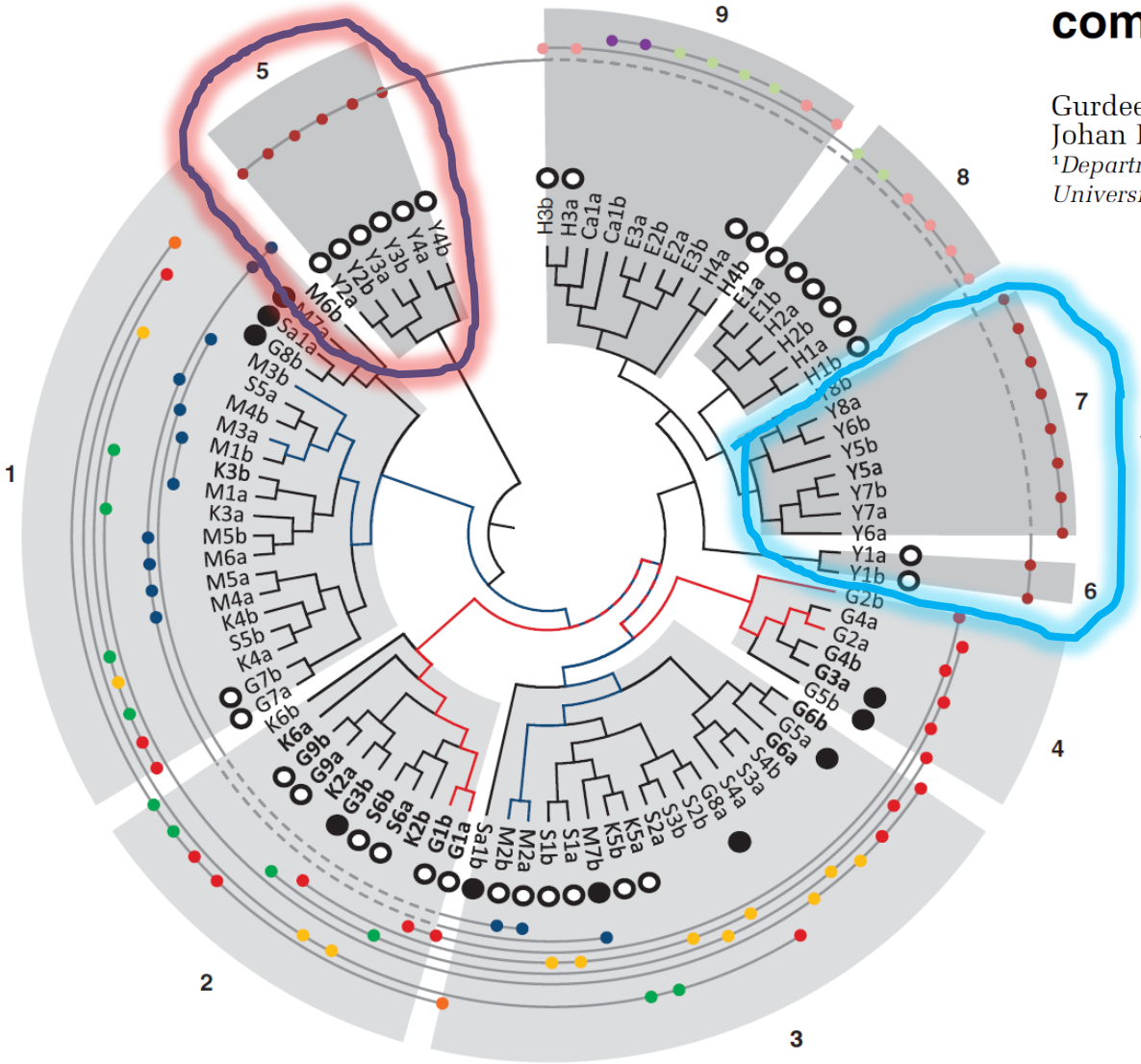
Yuma Dust Storm Microbial Community



ORIGINAL ARTICLE

Leaf microbiota in an agroecosystem: spatiotemporal variation in bacterial community composition on field-grown lettuce

Gurdeep Rastogi[1], Adrian Sbodio[2], Jan J Tech[1], Trevor V Suslow[2], Gitta L Coaker[1] and Johan HJ Leveau[1]

[1]*Department of Plant Pathology, University of California, Davis, CA, USA and* [2]*Department of Plant Sciences, University of California, Davis, CA, USA*

Yuma typical Romaine microbial community

WHY GUESS? – dust storms change the microbial community and bring new 'transients' to crops

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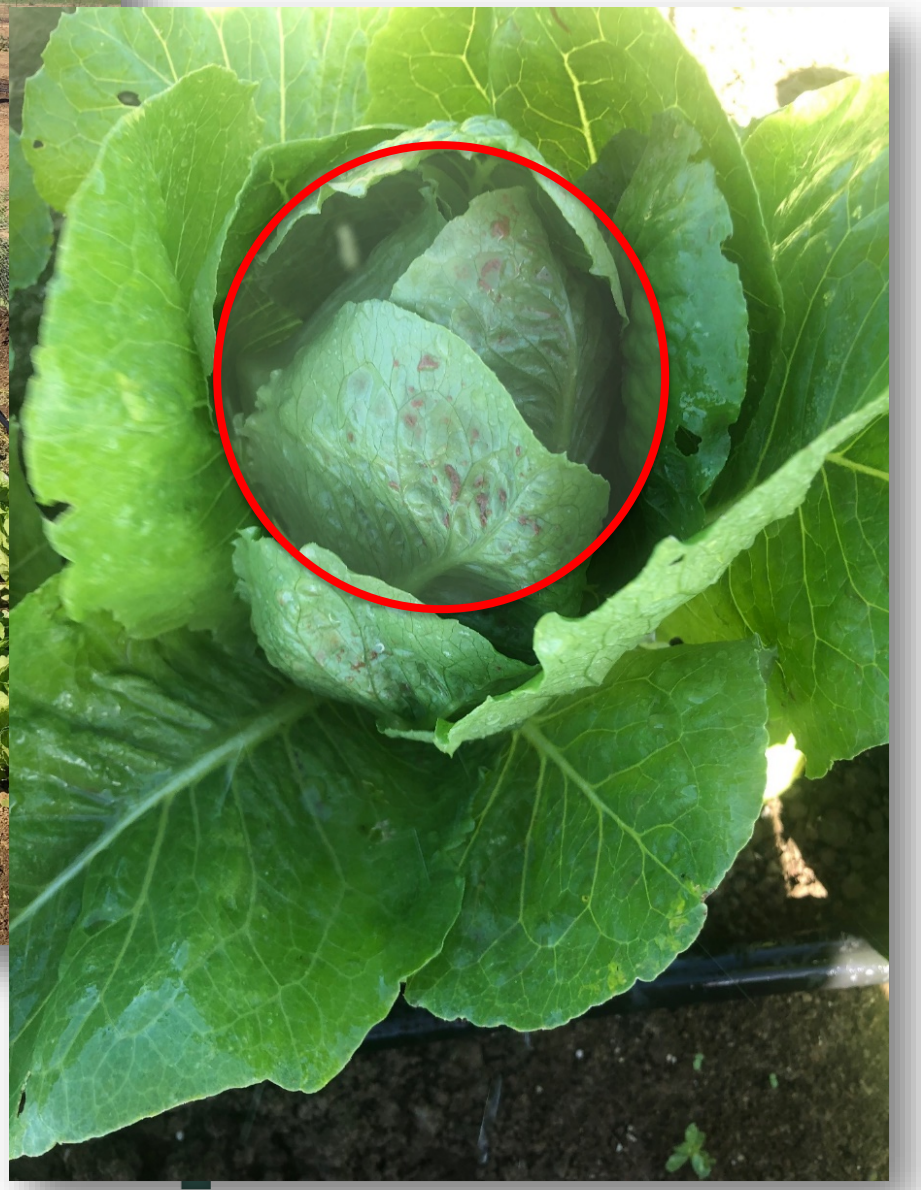
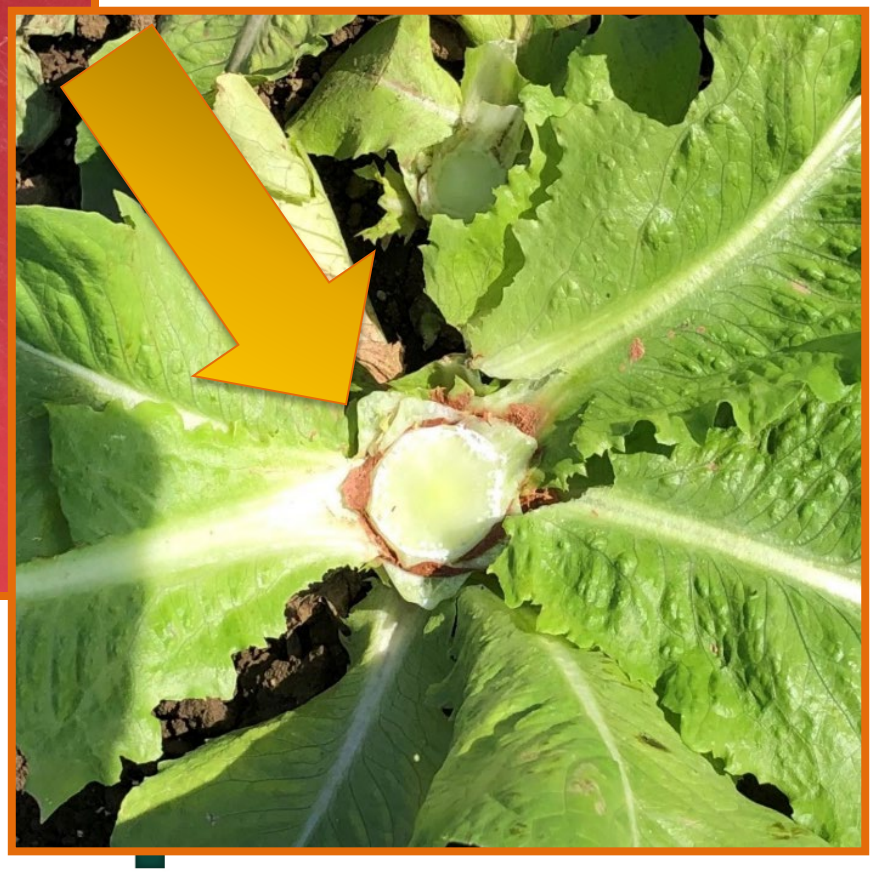


What is the survival and redistribution of a bioaerosol landing on mature Romaine?

UCD 2019 Field Demo

Post-irrigation movement of organic carrier down towards basal sector

Organic dust accumulates at basal leaf whorl

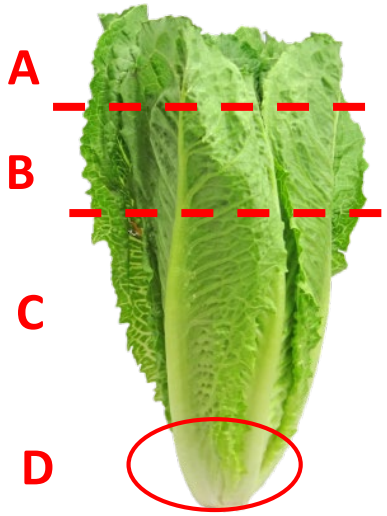


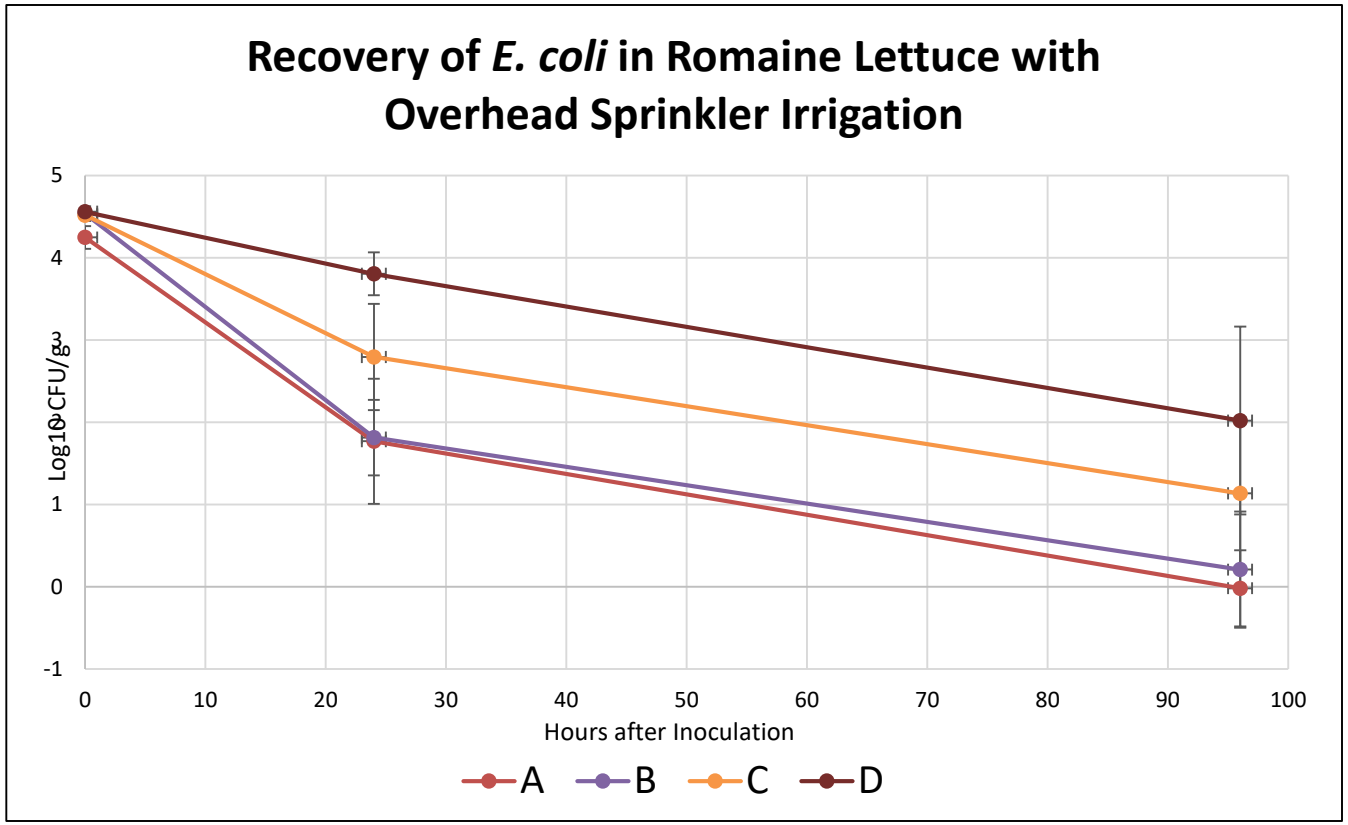
Recovery of *E. coli*$_{rif}$ in Feclone from Romaine Lettuce Plants with Overhead Sprinkler Irrigation

Air Temperature During Field Trial

Hour	High (°F)	Low (°F)
0	86	52
24	80	62
48	87	68
72	93	65
96	102	68

Analysis Sectioning of Romaine Lettuce





At 96h, after three irrigation events, there is a concentration of generic *E. coli* at the bottom of the Romaine Lettuce plant at sections C and D.

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5 People Died From Eating Lettuce, But Trump's FDA Still Won't Make Farms Test Water For Bacteria

09/27/2018 11:26 am ET | **Updated** Sep 27, 2018

PAUL SAKUMA/ASSOCIATED PRESS

A worker harvests romaine lettuce in Salinas, Calif., in August 2007. After an E. coli outbreak on spinach killed three people in 2006, California and Arizona growers of leafy greens voluntarily agreed to test their irrigation water and take other safety steps.

By Elizabeth Shogren and Susie Neilson

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Furrow Irrigation:

Majority of implicated Yuma fields furrow irrigated to maturity

Is transference a reasonable and foreseeable risk factor to resolve?

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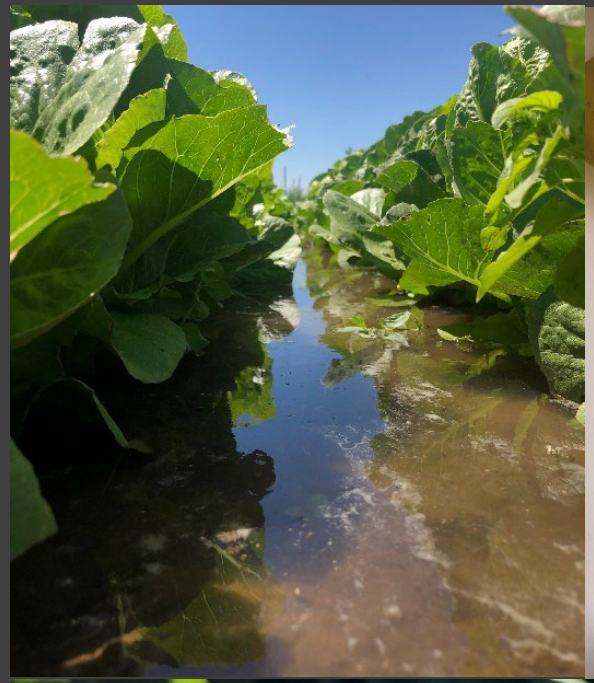

Project Outline

- Furrow water with generic *E. coli*$_{Rif}$ sachets
  - **Trial 1 – Low Inoculation – Log 1**
  - **Trial 2 – High Inoculation – Log 5**
- Bed-edge cross-contact with lowest leaves
- Furrow dry to walkable (~ 3 days)
- Harvest romaine lettuce heads
- Test **knife and platform**
- Sample non-harvest leaves
- Sample head (**market head) t**o platform
- Cut and invert for 20 minutes before removing from field (**Inverted Leaves**)
- Sample **furrow soil.**

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E. coli Persistence in Furrow Soil

Key

Positive for E.coli- rif

Negative for E.coli - rif

Low Log 1 Inoculation

E. coli **recovery from furrow soil samples in Trial 1 at 8 days**

Furrow Soil Sample	Enrichment
1	+
2	+
3	+
4	+
5	+
6	+
7	+
8	+
9	+
10	+

High Log 5 Inoculation

E. coli **recovery from furrow soil samples in Trial 2 at 8 days**

Furrow Soil Sample	Enrichment
1	+
2	+
3	+
4	+
5	+
6	+
7	+
8	+
9	+
10	+

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E. coli Recovery from Romaine Lettuce Lowest Non-market Leaves

Low Log 1 Inoculation

***E.coli* recovery from leaves that came in contact with furrow water for Trial 1**

Lowest Leaves	Reps	LogCFU/g	Average LogCFU/g	SD	Enrichment
Bed 1	1	0.86	0.63	0.48	+
	2	0.08			+
	3	0.95			-
Bed 2	1	0.26	0.29	0.58	+
	2	0.89			+
	3	Below LOD			-
Bed 3	1	-0.22	0.14	0.32	+
	2	0.26			+
	3	0.38			+

High Log 5 Inoculation

***E.coli* recovery from leaves that came in contact with furrow water for Trial 2**

Lowest Leaves	Reps	LogCFU/g	Average Log CFU/g	SD
Bed 1	1	4.43	4.33	0.22
	2	4.49		
	3	4.09		
Bed 2	1	4.00	3.65	0.33
	2	3.35		
	3	3.60		
Bed 3	1	3.50	2.89	0.57
	2	2.78		
	3	2.38		

Limit of Detection (LOD) = -Log 0.27/g

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E. Coli Recovery from Market-Head Romaine Lettuce Leaves (not inverted)

Low Log 1 Inoculation

E. coli **recovery of marketable Romaine Leaves in Trial 1**

Market Leaves	Reps	LogCFU/g	Enrichment
Bed 1	1	Below LOD	-
	2	Below LOD	-
	3	Below LOD	-
Bed 2	1	Below LOD	-
	2	Below LOD	-
	3	Below LOD	-
Bed 3	1	Below LOD	-
	2	Below LOD	-
	3	Below LOD	-

Limit of Detection (LOD) = -Log0.27/g

High Log 5 Inoculation

E. coli **recovery of marketable Romaine Leaves Trial 2**

Market Leaves	Reps	LogCFU/g	Enrichment
Bed 1	1	Below LOD	-
	2	Below LOD	-
	3	Below LOD	-
Bed 2	1	Below LOD	+
	2	Below LOD	+
	3	Below LOD	+
Bed 3	1	-0.22	
	2	Below LOD	+
	3	0.38	

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E. coli Recovery from Inverted Market-Head Romaine Lettuce Leaves

High Log 5 Inoculation

Inverted Romaine	Reps	Log CFU/g	Average Log CFU/g	SD
Bed 1	1	1.56	1.43	0.13
	2	1.44		
	3	1.30		
Bed 2	1	2.42	2.36	0.06
	2	2.31		
	3	2.36		
Bed 3	1	2.68	2.66	0.08
	2	2.57		
	3	2.73		
Bed 3	1	2.36	2.33	0.02
	2	2.34		
	3	2.31		

***E. coli* was recovered from top leaves of heads inverted onto the basal leaves for 20 minutes.**

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Cross Contamination - Knife

Low Log 1 Inoculation

E. coli **recovery from swabs of knife used during harvesting in Trial 1**

Lettuce Harvested	Knife
16	-
32	-
48	-
64	+
80	+
96	+
112	-
128	+
144	-
160	+
176	+
192	-
208	-
224	-
240	+

High Log 5 Inoculation

E. coli **recovery from swabs of knife used during harvesting in Trial 2**

Lettuce Harvested	Knife
12	+
24	+
36	+
48	+
60	+
72	+
84	+
96	+
108	+

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Cross Contamination - Surfaces

Low Log 1 Inoculation

E. coli **recovery from swabs of surfaces that came in contact with romaine lettuce heads (metal tray and cutting board) in Trial 1**

Lettuce Harvested	Metal Tray	Cutting Board
8	-	-
16	-	-
24	-	+
32	-	-
40	-	-
48	-	-
56	-	-
64	-	-
72	-	-
80	-	-
88	-	-
96	-	-
104	+	-
112	-	-
120	-	+

High Log 5 Inoculation

E. coli **recovery from swabs of surfaces that came in contact with romaine lettuce heads (metal tray and cutting board) in Trial 2**

Lettuce Harvested	Metal Tray	Cutting Board
6	-	+
12	+	+
18	+	+
24	+	+
30	+	+
36	+	+
42	+	+
48	+	+
54	+	+

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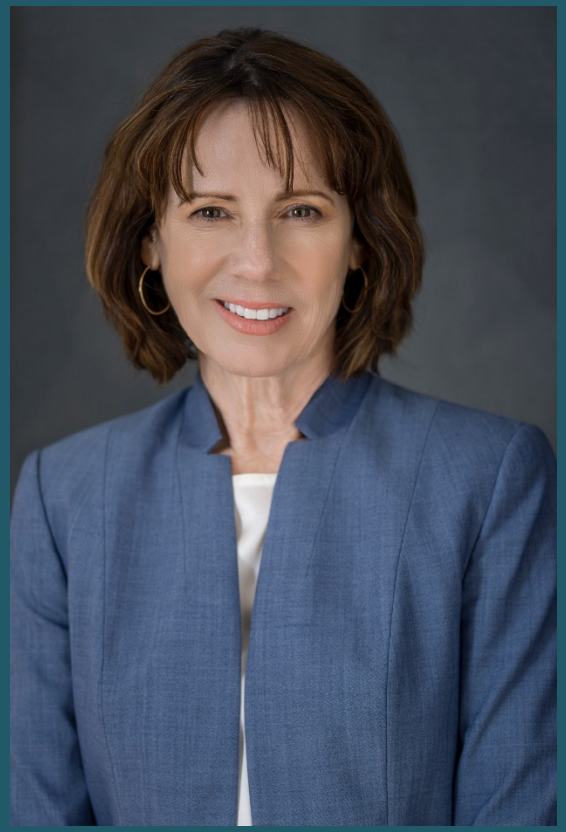
What are the integrated solutions?

- Deadhead buffer at field ends
- Raise bed height
- Modify cut-to-ground
- Change pre-harvest sampling protocols
  - Testing is not a food safety plan, but…
- Your input would be to …



Bonnie Fernandez-Fenaroli
Executive Director
Center for Produce Safety

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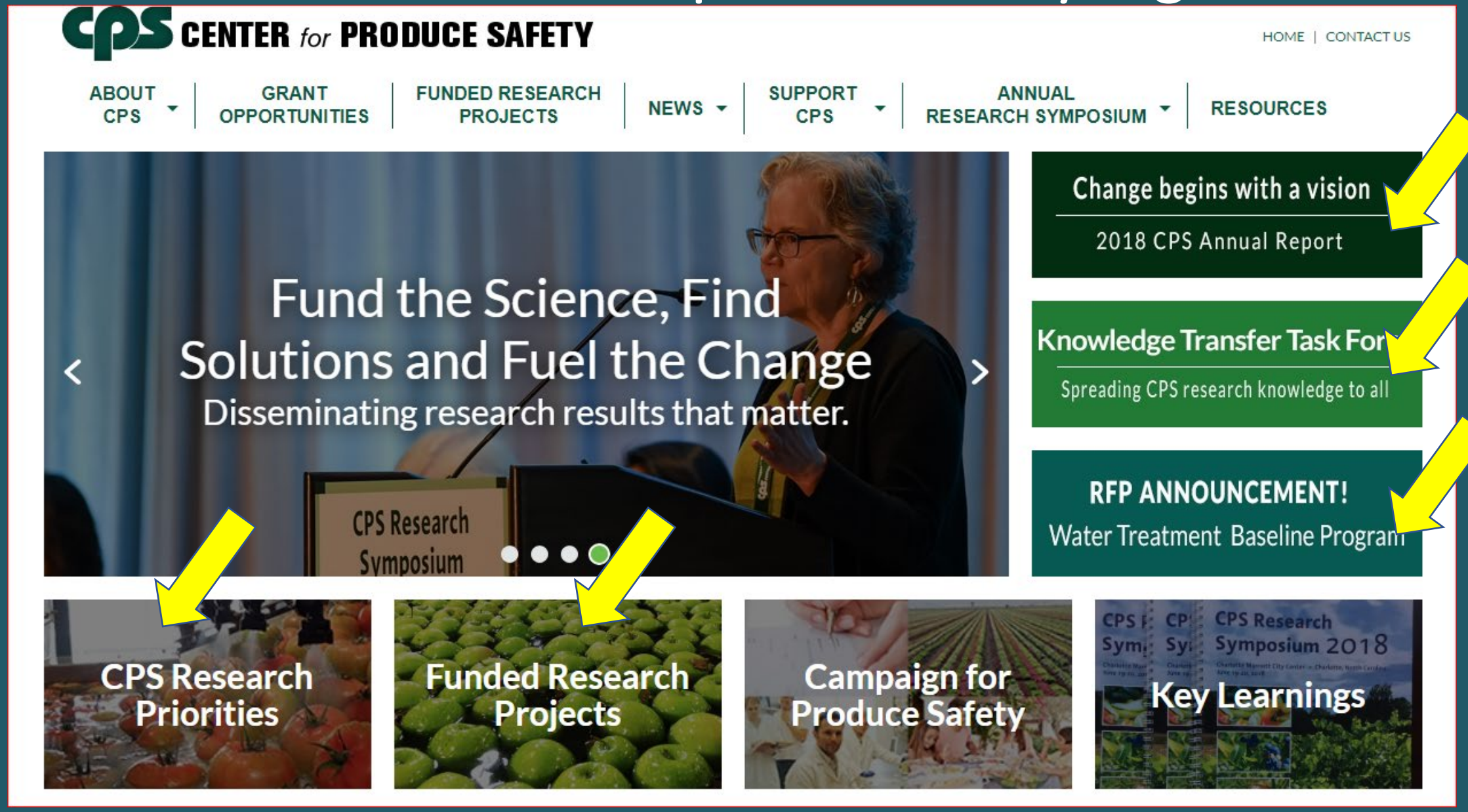
www.centerforproducesafety.org



Questions?
Please use chat box

THANK YOU.

YOUR TIME AND INTEREST IS APPRECIATED

SEND ADDITIONAL QUESTIONS TO:

INFO@CENTERFORPRODUCESAFETY.ORG

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