# Survival and Internalization of *E. coli* and *Salmonella* on Spinach and Lettuce Under Commercial Salinas Valley Field Conditions

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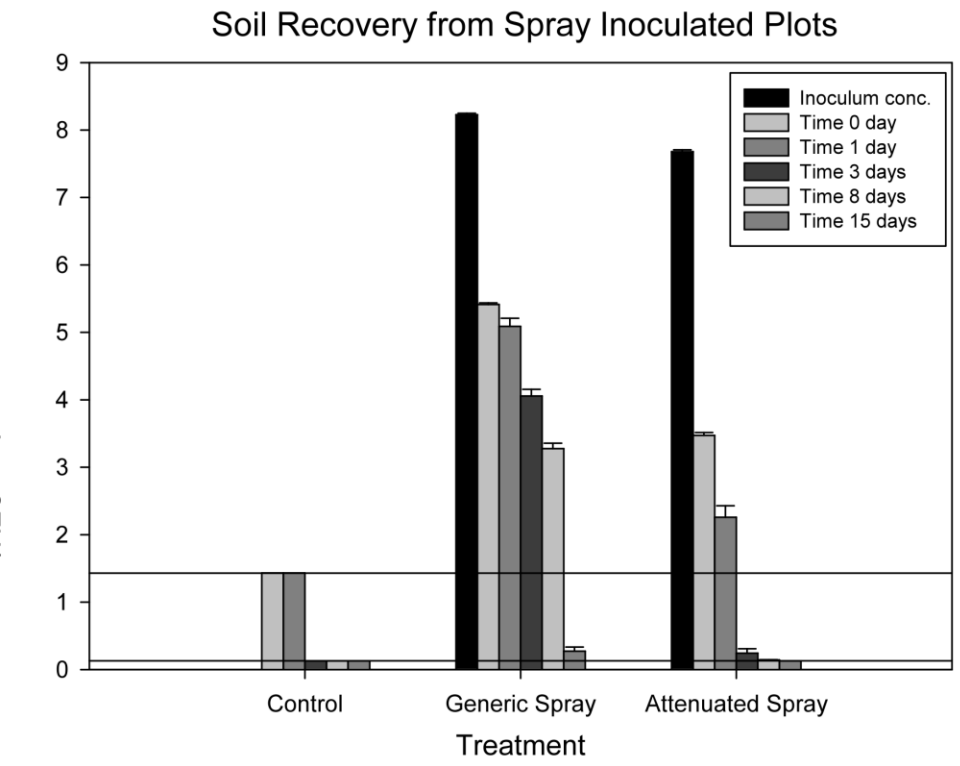
**2006**

***E. coli* O157:H7**

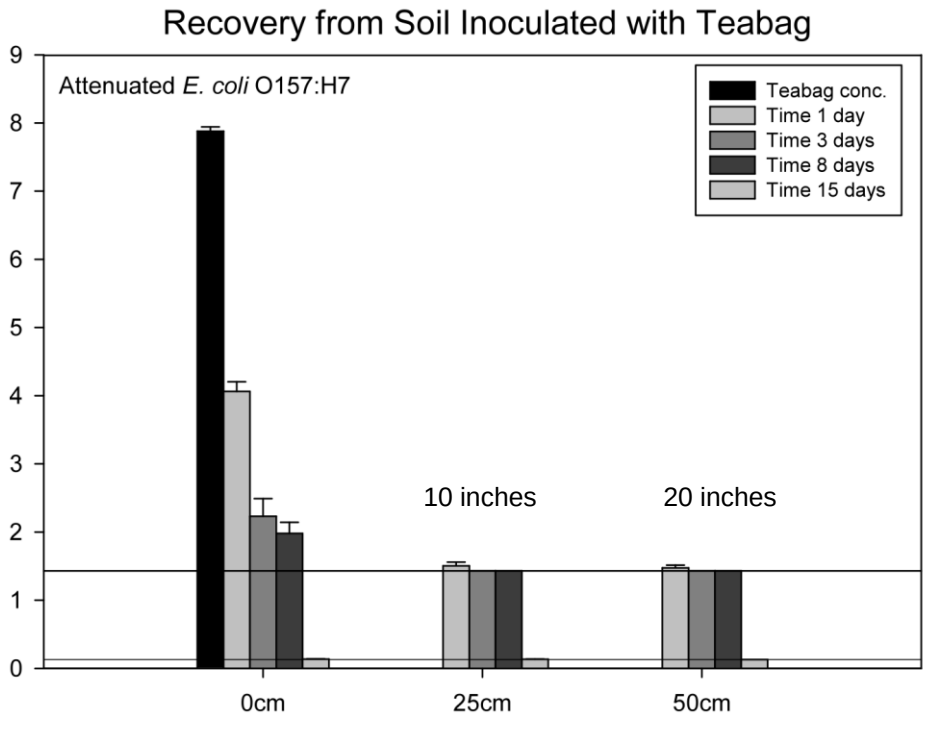
**Would contaminated soil/water result in contaminated crops (pre-emerge)?**

Pre-emergence inoculation /
Test for persistence and spread.

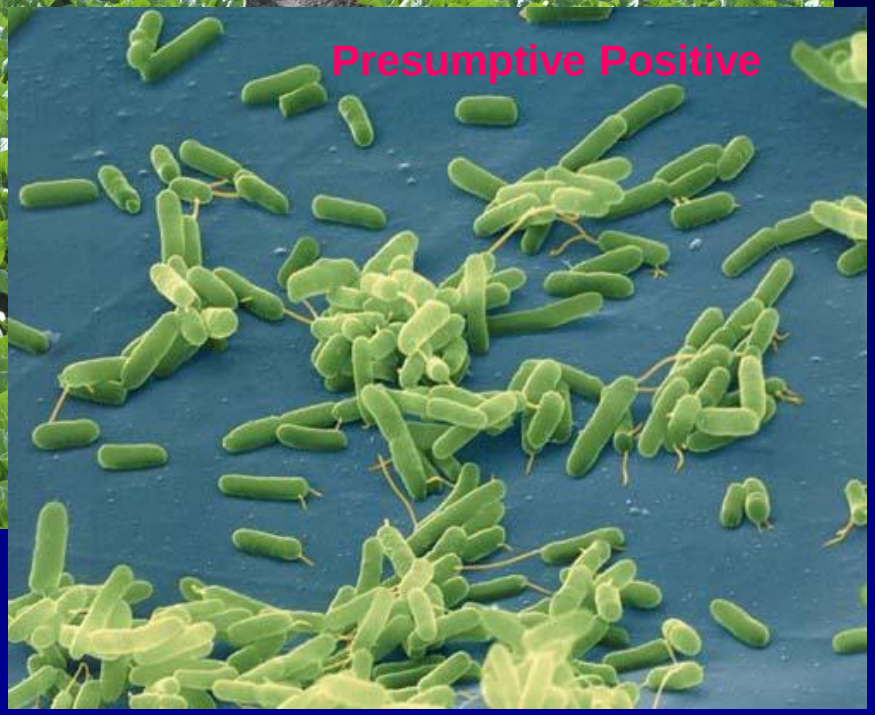



**Spray inoculation:**
**short survival in soil**
**generic & attenuated similar**
**no spread to spinach plants**

**Bag inoculation:** ➔
**short survival of in soil**
**generic & attenuated similar**
**little spread beyond mesh bags**
**no spread to plants**

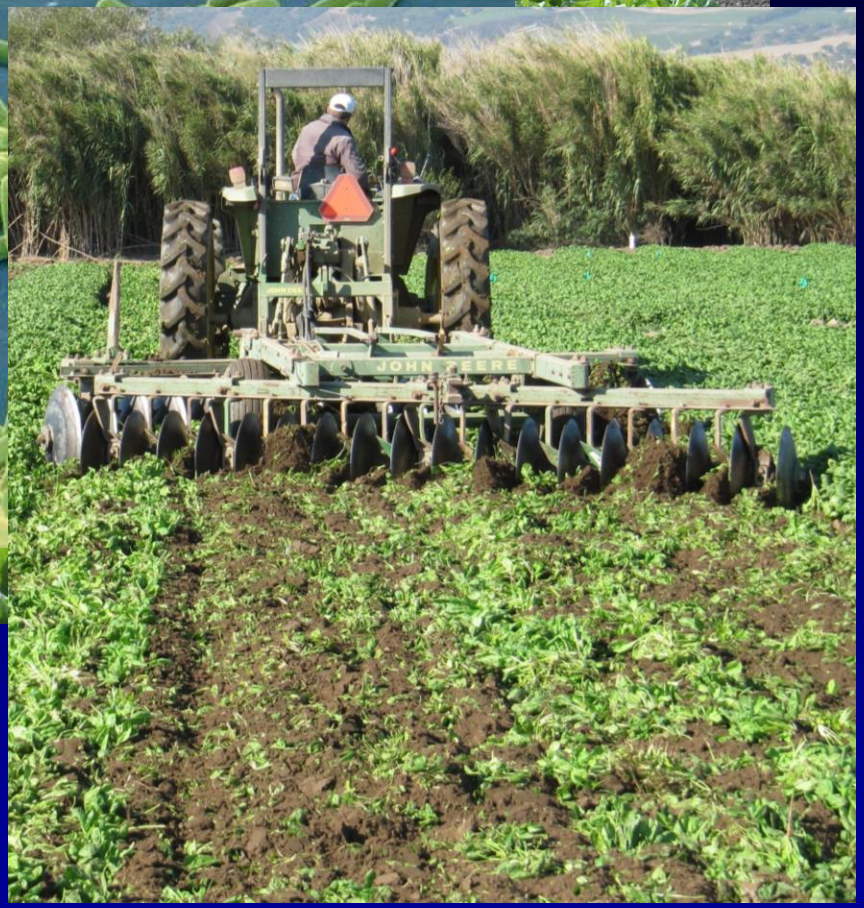


**What happens to contaminated crop residues when disked into the soil?**


Presumptive Positive

Presumptive Positive

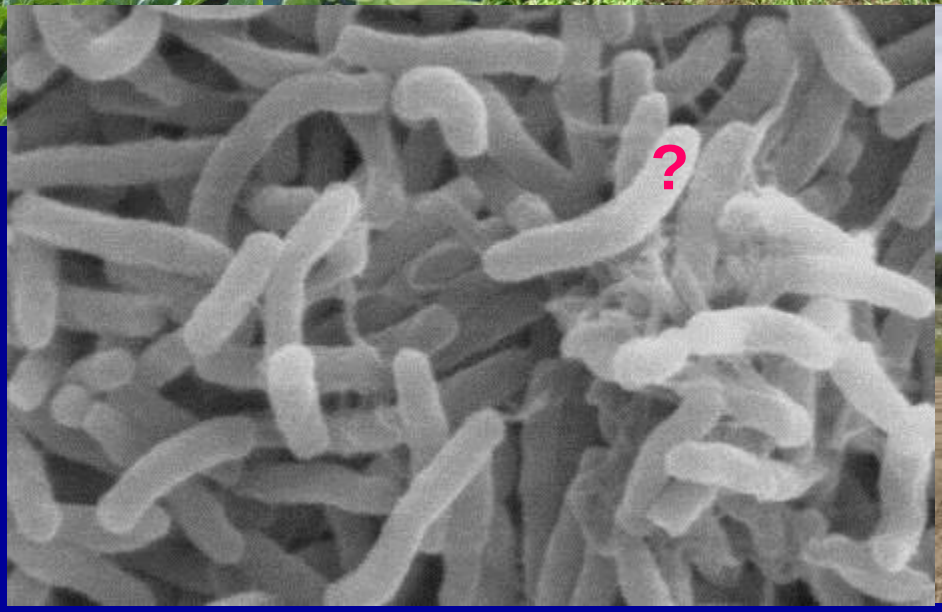




Presumptive Positive







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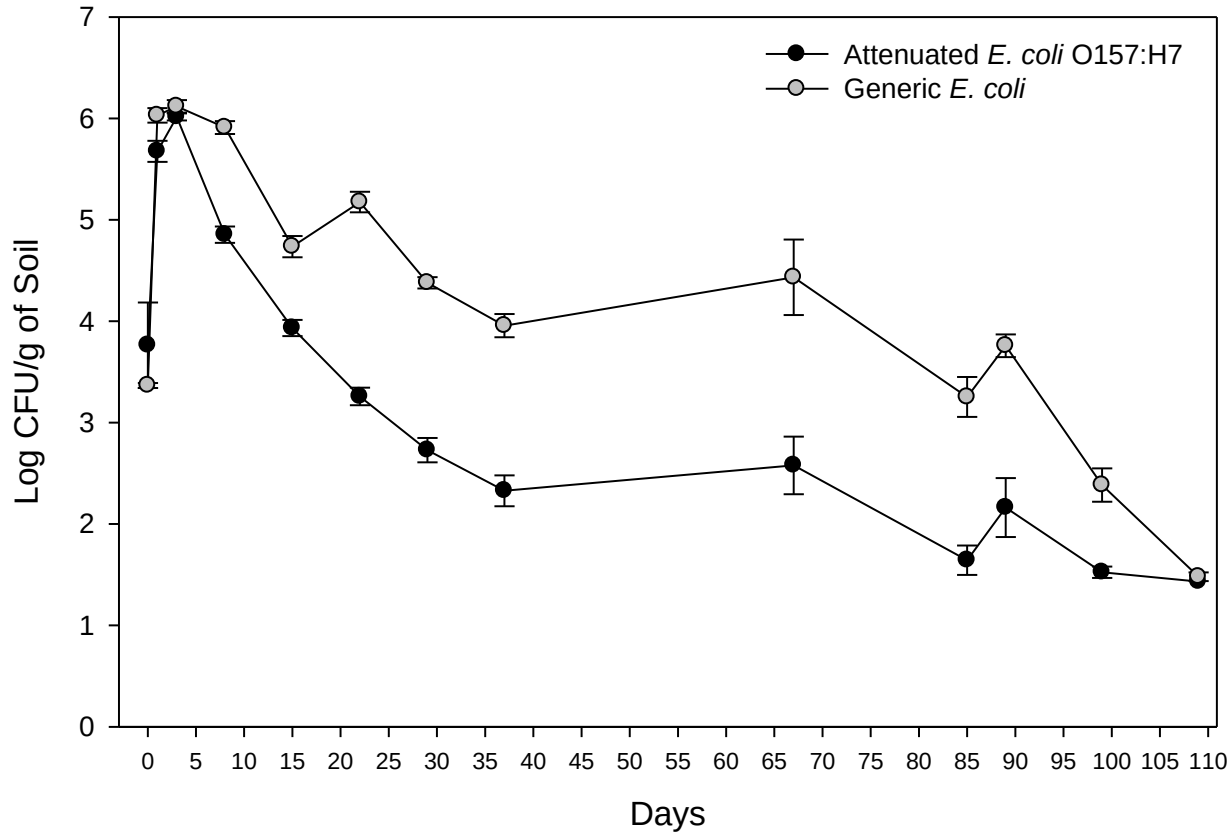
**At-harvest crop inoculation / Incorporation / Test for persistence and spread.**

Survival of Attenuated and Generic *E. coli* in Soil after incorporation of Spray-Inoculated 5-week-old Spinach Plants




Inoculum concentrations
Attenuated cocktail: Log 7.6 CFU/ml
Generic *E coli* cocktail: Log 8 CFU/ml

**On disked spinach, *E. coli* survived in soil for over 100 days**

**What production practices might enhance die-off of bacteria in crop residues?**

# First planting

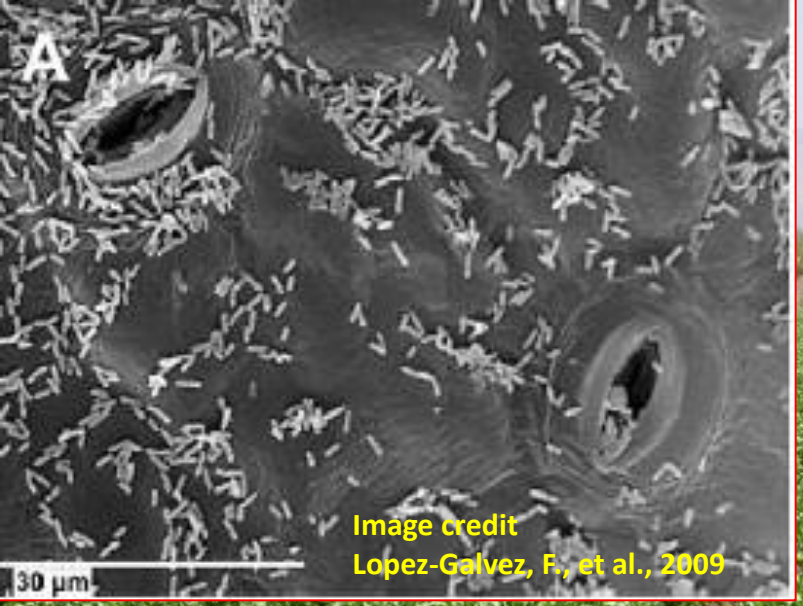
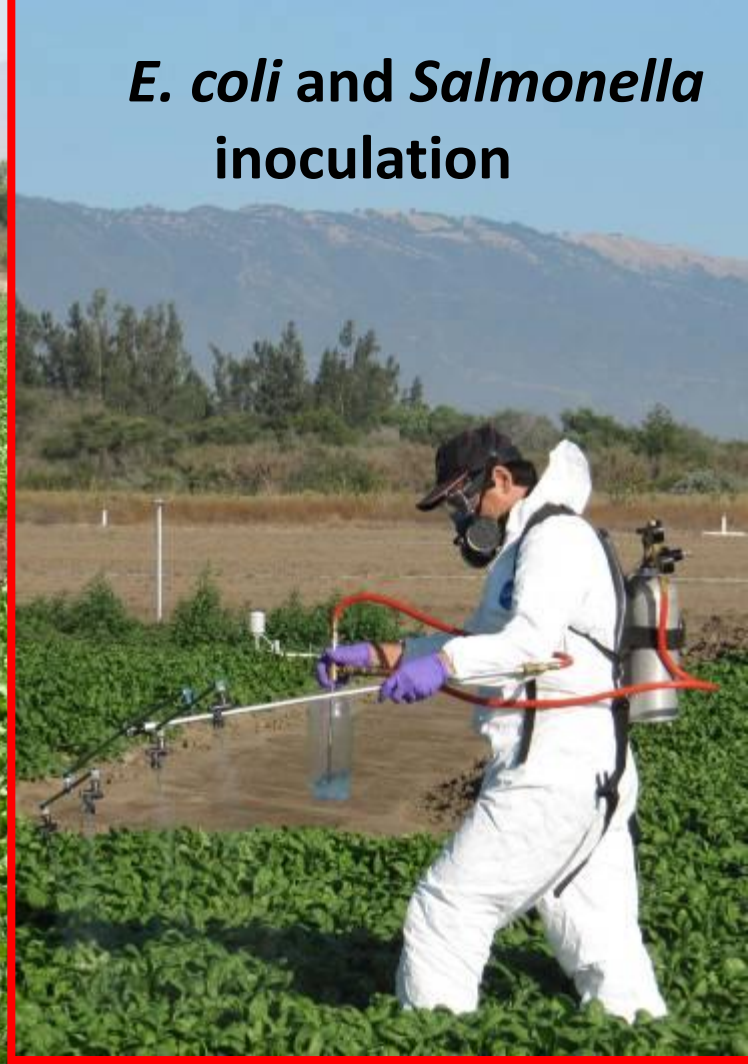
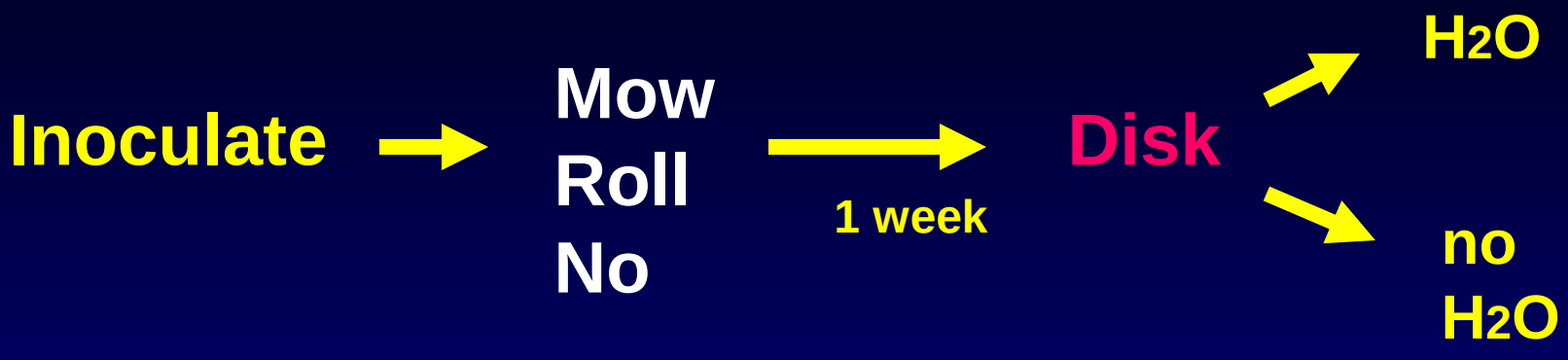



Image credit
Lopez-Galvez, F., et al., 2009



## *E. coli* and *Salmonella* inoculation

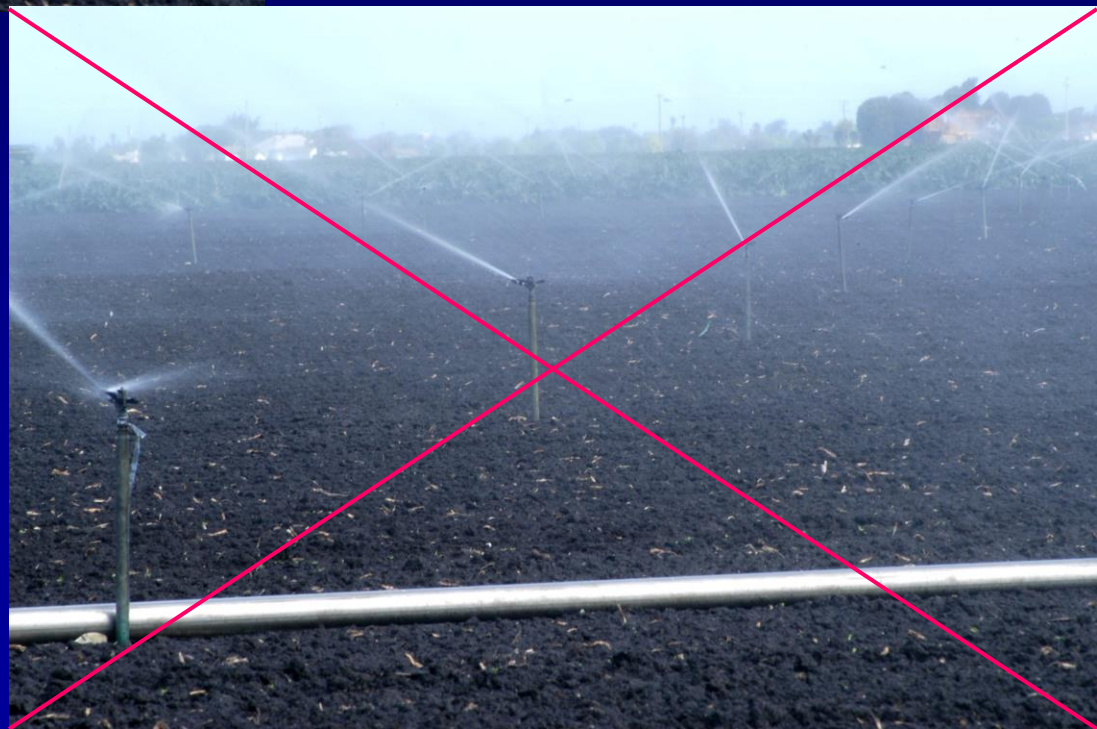

Inoculate
Mow
Roll
No
1 week
Disk
H2O
no
H2O

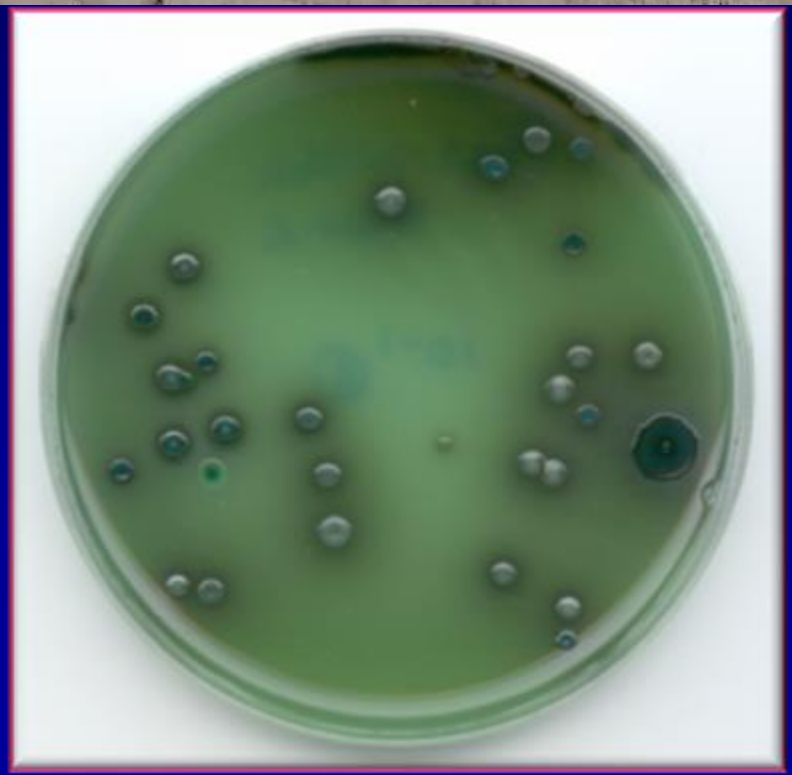

Inoculate
Mow
Roll
No
Disk
same day

# Mowed

# Ring-rolled

# Disked





# *E. coli* and *Salmonella* soil recovery

Inoculate, wait 48 hours

Apply treatments (mow, ring-roll, no), wait one week, disk

| Treatment | | | log CFU/g of soil ± std error | | | |
|---|---|---|---|---|---|---|
| | | | 9 DPI | | 10 DPI | |
| | | | *E. coli* | Salmonella | *E. coli* | Salmonella |
| Not Mowed | no extra irrigation | 1 | nd | nd | nd | nd |
| | extra irrigation after one week | 2 | nd | nd | nd | low pos |
| Mowed | no extra irrigation | 3 | nd | nd | nd | nd |
| | extra irrigation after one week | 4 | nd | low pos | nd | low pos |
| Ring-roll | no extra irrigation | 5 | nd | nd | nd | nd |
| | extra irrigation after one week | 6 | nd | low pos | nd | nd |

***E. coli* less persistent than *Salmonella.***

**(low = low numbers after concentration; no numerical data.)**

# Enrichments results

## Apply treatments (mow, ring-roll, no), wait one week, disk

| Treatment | | | *E. coli* enrichment 9 DPI | 10 DPI | 15 DPI | 20 DPI |
|---|---|---|---|---|---|---|
| Not Mowed | no extra irrigation | 1 | **0/4** | **1/4** | **0/4** | **0/4** |
| | extra irrigation after 1 week | 2 | **0/4** | **2/4** | **0/4** | **2/4** |
| Mowed | no extra irrigation | 3 | **1/4** | **1/4** | **0/4** | **0/4** |
| | extra irrigation after 1 week | 4 | **0/4** | **3/4** | **0/4** | **0/4** |
| Ring-roll | no extra irrigation | 5 | **0/4** | **1/4** | **0/4** | **0/4** |
| | extra irrigation after 1 week | 6 | **0/4** | **2/4** | **0/4** | **0/4** |

| Treatment | Attn Salmonella enrichment 9 DPI | 10 DPI | 15 DPI | 20 DPI |
|---|---|---|---|---|
| 1 | **0/4** | **1/4** | **1/4** | **2/4** |
| 2 | **1/4** | **2/4** | **2/4** | **1/4** |
| 3 | **1/4** | **1/4** | **0/4** | **3/4** |
| 4 | **2/4** | **3/4** | **4/4** | **4/4** |
| 5 | **0/4** | **1/4** | **0/4** | **2/4** |
| 6 | **2/4** | **1/4** | **3/4** | **4/4** |

## Apply treatments (mow, ring-roll, no) and disk same day

| Treatment | | | *E. coli* enrichment 2DPI | 3DPI | 8DPI | 13DPI |
|---|---|---|---|---|---|---|
| Not Mowed | no extra irrigation | 7 | **0/4** | **0/4** | **0/4** | **0/4** |
| Mowed | | 8 | **2/4** | **1/4** | **1/4** | **1/4** |
| Ring-roll | | 9 | **0/4** | **0/4** | **0/4** | **0/4** |

| Treatment | Attn Salmonella enrichment 2DPI | 3DPI | 8DPI | 13DPI |
|---|---|---|---|---|
| 7 | **0/4** | **0/4** | **0/4** | **2/4** |
| 8 | **3/4** | **3/4** | **2/4** | **3/4** |
| 9 | **0/4** | **0/4** | **0/4** | **1/4** |

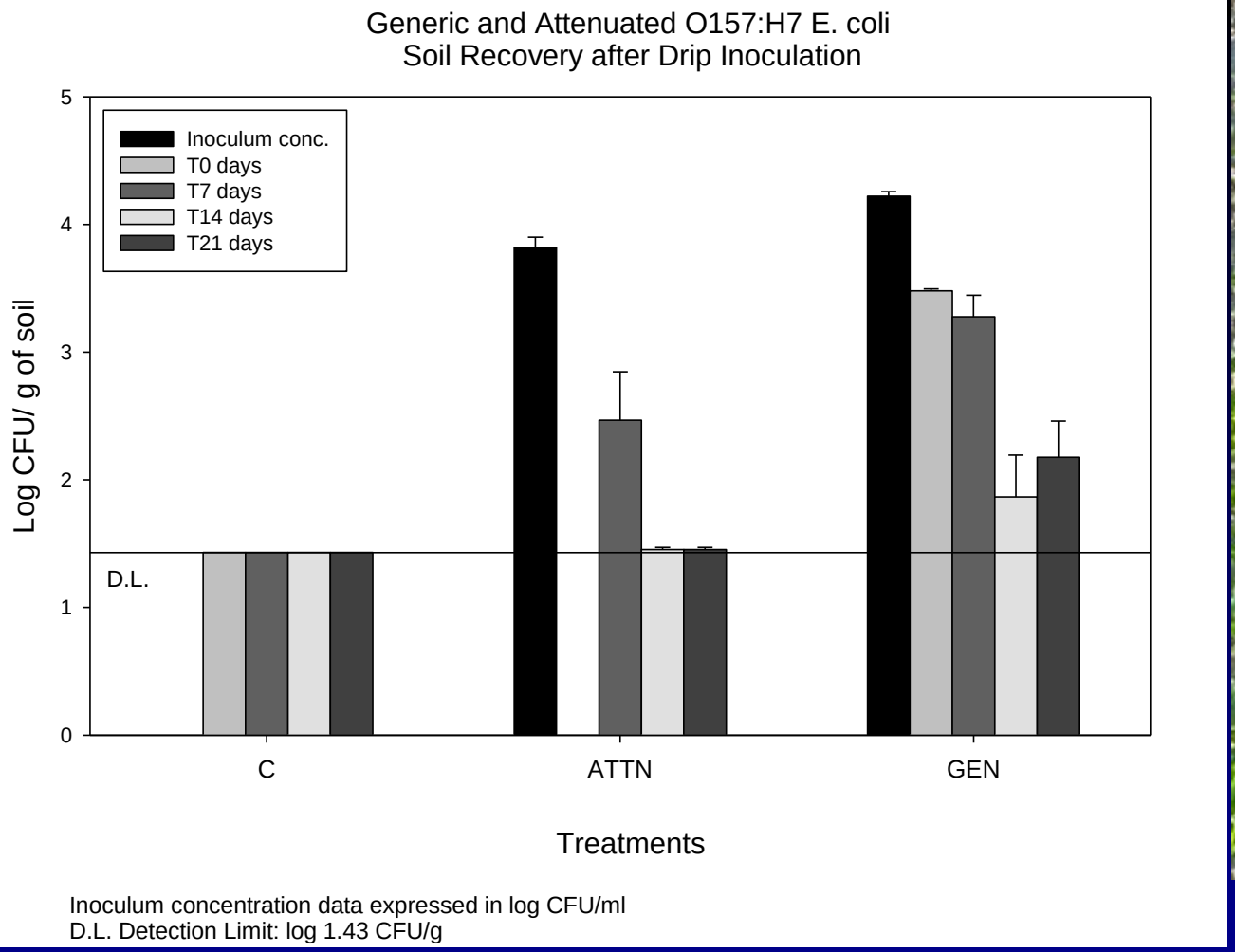
# Second planting

# Bacterial recovery: Second crop

- **No plants tested positive for *E. coli* at 27 and 35 days after planting (dap).**
- **Plants from six plots tested positive for *Salmonella* at 27 dap.**
- **No *Salmonella* was detected at 35 dap.**

**Do crop roots absorb bacteria?**
**Are bacteria transported to leaves (internalization)?**

**Inoculate roots via sub-surface drip system.**




***E. coli*** **survived in soil for up to 21 (generic) or 7 (attenuated) days.**

***E. coli*** **not found in plants (no internalization).**

# Key findings from field research

- *Salmonella* persisted longer than *E. coli.*
- Pre-emerge contaminated water and soil:
  - Bacteria do not end up on crop
- Leaving residues on top of soil:
  - enhanced die-off
- Residue treatment mode not critical?
  - Ring-roller better?
- Internalization does not occur in the field.

# Acknowledgments


- Research teams: Steven Koike, Michael Cahn, Richard Smith, Laura Murphy, Trevor Suslow, Adrian Sbodio.
- We acknowledge the support of the Center for Produce Safety, California Leafy Greens Research Board, and the leafy greens industry in California.
- We thank the following: Bonnie Fernandez, Leslie Maulhardt, June Rasmussen, David Costa, Gilbert Hernandez, Joe Sproul, Mike Hardoy, Kevin Vaughn, Brian Lopez, Patty Ayala, Sharon Benzen, Chris Bettiga, Keith Day, Mike German, Kat Kammeijer, Eric Lauritzen, Mary Zischke, NewStar, Wilbur-Ellis, Seminis Seeds, and many others.