Water, Irrigation, and Impacts on E. coli

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UC Cooperative Extension: Long-Term Objectives

• Conduct practical field studies that contribute to an understanding of how E. coli and other foodborne pathogens exist and survive in agriculture.

• Provide guidance for minimizing risks from foodborne pathogens and for improving metrics and regulatory guidelines.
2007 Field Experiments

• Examine soil survival of generic E. coli under field conditions.

• Evaluate irrigation methods and soil nutrient levels on generic E. coli survival.

• Develop and refine detection methods for E. coli research.
Field Trial 1

Objective: Evaluate generic E. coli survival in soil under different rates of sprinkler applied water

- Replicated small plots (40-inch bed x 20 feet).
- Four E. coli treatments (water, soil, plant, combo.).
- Two concentrations (10^6, 10^8 cfu/ml) each.
- Selected for antibiotic resistance (rif mutant).
- Sprinkler irrigated every 2 days (5 times total).
- Water volumes were measured.
- Monitor E. coli rif survival in soil.
QuantiTray

Yellow = Neg.  Red = Coliform  UV = “E. coli”
Field Trial 1 Results

• E. coli rif recovered from soil up to 8 days.
• By 14 days, E. coli rif no longer detected (w/ exception of two plots).
• Higher recovery rates associated with the larger amounts of applied water.
• Applied strains were never detected in adjacent uninoculated plots.
Field Trial 1

48 h count

log CFU/gr

Inoculum
Time 0
4 days
8 days

Control
Plant log6
Plant log8
Water log6
Water log8
Soil log6
Soil log8
Cocktail

1st inoculated
3rd inoculated
2nd inoculated

Treatment
Block A & B differences

Log CFU/gr of soil

- Block A (North)
- Block B (South)

Treatment:
- Cocktail
- Plant log 8
- Water log 8
- Soil log 8
Applied Water at Field Trial 1

Distance from Sprinkler Line (feet)

Applied Water (inches)

- North Side 1st irrigation
- South Side 1st irrigation
- North Side total of subsequent irrigations
- South Side total of subsequent irrigations
Field Trial 2: Field SVR 51

Objective: Compare soil survival of generic E. coli under sprinkler/drip and with high/standard nutrient inputs.

• Replicated large plots (three 40-inch beds x 145 feet).
• Treatments:
  • Irrigation: drip, sprinklers
  • E. coli rif \(10^7\): noninoculated, inoculated
  • Fertilizer: grower std, grower std + 350 lb N/acre + 250 lb P/acre
• Plant romaine; follow E. coli survival in soil, in runoff water (sprinkler plots only), on plants.
• Target lettuce harvest: September.
SVR 51 Results A

- E. coli rif recovered from soil for only a short period of time (up to 3 days).
- Irrigation methods and nutrient levels had no effect on E. coli survival in soil.
- By 6 d, E. coli rif no longer detected.
- No detection of E. coli rif on lettuce:
  - seedling roots and rhizosphere soil
  - seedling leaves
  - larger plant leaves
  - plants of harvestable size
E. coli survival in soil

Day 0, 3 and 6. Samples were collected at the north side of each plot.
Day 13. Samples consisted in a composite from 10 sub-samples distributed along the plot.
Data only from Davis analysis.
SVR 51 Results B

• Sprinkler irrigation runoff: E. coli rif detected up to 12 days after inoculation.
• E. coli rif strains were not detected in adjacent uninoculated plots/lettuce.
• Coliform bacteria were recovered from runoff for the duration of the trial.
Coliform Bacteria in Sprinkler Run-off from SRV 51 field trial

Detection limit = 24196 MPN/100 ml

- Control (not inoculated)
- Inoculated w/ rif E. coli
- Inoculated w/ rif E. coli + nutrients

Days after Inoculation

MPN/100 ml
SVR 51 Results C

- Starting from 26 days post inoculation, we recovered presumptive E. coli (growth on rif medium; fluorescence on MUG medium) from plants and runoff from inoculated plots.
- Late in experiment: found presumptive E. coli from uninoculated plots.
- However, all these isolates were later found to be false positives (ID = Enterobacter species).
Presumptive E. coli in Sprinkler Run-off from SRV 51 field trial

Detection limit = 1 MPN/100 ml

Days after Inoculation

MPN/100 ml

- Control (not inoculated)
- inoculated w/ rif E.coli
- inoculated w/ rif E. coli + nutrients
Summary for Generic E. coli in Field Studies

• Simulation of a one-time, high level contamination event (w/ E. coli rif) resulted in very short persistence.
• Irrigation method/nutrient level did not affect survival of E. coli in soil or in plant tissue.
• Presumptive E. coli was detected in sprinkler run-off water collected from furrows.
• Water appears to play key role in survival.
• Testing issue raised: positives with non-E. coli on ECC, TSA, QuantiTray assays?
E. coli or not E. coli?
**E. coli in Irrigation Run-off and Creeks East-side Salinas Valley (9/6/07)**

Bacterial TMDL proposed for the Lower Salinas Valley surface water:

<table>
<thead>
<tr>
<th>Site Description</th>
<th>MPN/100 ml</th>
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<tbody>
<tr>
<td>1. Irrigation run-off high sediment load</td>
<td>&gt; 24196</td>
</tr>
<tr>
<td>2. Irrigation run-off high sediment, road creek</td>
<td>&gt; 24196</td>
</tr>
<tr>
<td>(downstream from 2)</td>
<td></td>
</tr>
<tr>
<td>3. Creek (downstream from 2)</td>
<td>&gt; 24196</td>
</tr>
<tr>
<td>4. Irrigation run-off high sediment load</td>
<td>&gt; 24196</td>
</tr>
<tr>
<td>5. Irrigation run-off high sediment basin</td>
<td>&gt; 24196</td>
</tr>
<tr>
<td>6. Road-side run-off (downstream from 5)</td>
<td>&gt; 24196</td>
</tr>
<tr>
<td>7. Creek</td>
<td>&gt; 24196</td>
</tr>
<tr>
<td>8. Irrigation run-off (clear)</td>
<td>&gt; 24196</td>
</tr>
<tr>
<td>9. Road-side run-off (downstream from 8)</td>
<td>&gt; 24196</td>
</tr>
<tr>
<td>10. Irrigation run-off high sediment load</td>
<td>&gt; 24196</td>
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**Target for E. coli = 126 MPN/100 ml**
Acknowledgements:

1. California Lettuce Research Board
2. Grower cooperators
3. Research team: Patty Ayala, Elena Castro, Carol D’lima, Riley Hathaway, Kat Kammeijer, Eric Lauritzen, Salvador Montes, Lisa Quon, Adrian Sbodio, Arnett Young
Effect of Nutrients* on native Coliform Bacteria and Presumptive *E.coli* levels in Creek Water (site 3)

*50 ppm Nitrate-N, 10 ppm orthophosphate*
Effect of Nutrients* on Presumptive E. coli levels in autoclaved Creek Water (site 3)

*50 ppm Nitrate-N, 10 ppm orthophosphate