SALINITY MANAGEMENT IN PROCESSING TOMATOES

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WHERE DO SALTS COME FROM?

- Irrigation water is the primary source of salts in agricultural systems
- Also from fertilizers, manures, composts
- Shallow saline water tables

<table>
<thead>
<tr>
<th>Cations</th>
<th>Anions</th>
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</thead>
<tbody>
<tr>
<td>Sodium (Na⁺)</td>
<td>Chloride (Cl⁻)</td>
</tr>
<tr>
<td>Calcium (Ca²⁺)</td>
<td>Sulfate (SO₄²⁻)</td>
</tr>
<tr>
<td>Magnesium (Mg²⁺)</td>
<td>Bicarbonate (HCO³⁻)</td>
</tr>
</tbody>
</table>

Boron (B), Carbonate (CO₃²⁻), Nitrate (NO₃⁻), Potassium (K⁺)
HOW DOES SALT EFFECT PLANTS?

Overall salinity causes osmotic stress → Stunting, reduced yields

Specific ion toxicity (NA, Cl, B) → Marginal leaf burn

Physical changes to soil → Water infiltration problems
Crop Sensitivity to Salinity in Relation to Stage of Growth

After Maas and Grattan, 1999
TOMATOES ARE MODERATELY SENSITIVE TO SALINITY

ECₑ = Electrical Conductivity of the Saturation Extract (dS/m)

ECₑ = 1.5 ECₑ

ECₑ = Electrical Conductivity of the Irrigation Water (dS/m)

ESUITE FOR CROPS

SENSITIVE
MODERATELY SENSITIVE
MODERATELY TOLERANT
TOLERANT

Relative Crop Yield, %
dS/m

ECₑ
ECₑ
ECₑ
ECₑ
SALT PATTERN UNDER FURROW IRRIGATION
SALT PATTERN UNDER DRIP IRRIGATION
PROCEDURES

Two commercial field sites in the Delta region

- Furrow irrigated field
- Drip irrigated field (2014 was second year)
  - Grower’s schedule
  - Full irrigation in the early season followed by a deficit irrigation strategy

Both sites were transplanted with 60” bed configuration with single plant rows
• Both sites categorized as Egbert series
• Both irrigated with water sourced from the San Joaquin Middle River near Howard Road
PROCEDURES

Measurements:
• Fruit yield and quality
• Applied water volumes (drip field)
• Groundwater salinity
• Depth to water table
• Irrigation water salinity
• Soil salinity
DRIP-IRRIGATED FIELD

• Soil sampled on May 13 after pre-irrigation
• Transplanted to UG 19406 on May 23
• Irrigation cutbacks initiated on Aug. 14, 7 weeks before harvest
• Soil sampled and harvested on Sept 29-30
• EC of irrigation water averaged 0.6 dS/m
Inches of water applied

- Full Crop Evapotranspiration (ET - estimated)
- Applied water, grower rows
- Applied water, experimental rows
### Drip field - Electrical Conductivity (dS/m)

#### Pre-transplant May 13, 2014

<table>
<thead>
<tr>
<th>depth</th>
<th>0 - 4&quot;</th>
<th>4 - 8&quot;</th>
<th>8 - 12&quot;</th>
<th>12 - 16&quot;</th>
<th>16 - 20&quot;</th>
<th>20 - 24&quot;</th>
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<td>1.3</td>
<td>1.27</td>
<td>1.26</td>
<td>0.92</td>
<td>1.55</td>
<td>1.13</td>
<td>1.13</td>
</tr>
<tr>
<td>FURROW</td>
<td>1.62</td>
<td>1.16</td>
<td>1.12</td>
<td>1.32</td>
<td>1.14</td>
<td>1.08</td>
<td>1.29</td>
<td>1.32</td>
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#### Harvest Sept 29, 2014

<table>
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<tbody>
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<td>0.72</td>
<td>0.97</td>
<td>0.94</td>
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<td>0.95</td>
<td>0.94</td>
<td>1.14</td>
<td>1.26</td>
<td>1.70</td>
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#### Change in EC from spring to fall 2014

<table>
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<td>-0.20</td>
<td>-0.58</td>
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<tr>
<td>FURROW</td>
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<td>-0.59</td>
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<td>-0.23</td>
<td>-0.32</td>
<td>-0.11</td>
<td>-0.03</td>
<td>-0.01</td>
</tr>
</tbody>
</table>
FURROW FIELD

- Transplanted with H5608 on Apr 29
- Soil sampled on May 20
- Irrigated weekly using alternate furrows
- $EC_w$ averaged 0.62
- Last irrigation July 30
- Soil sampled Aug 29
- Harvested Sept 2
### Furrow field - Electrical Conductivity (dS/m)

#### Field bottom

<table>
<thead>
<tr>
<th>Depth (in)</th>
<th>3 wks after transplanting</th>
<th>At harvest</th>
<th>Changes in EC from spring to fall 2014</th>
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#### Electrical Conductivity (dS/m)

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<tbody>
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<td>16 - 20&quot;</td>
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</tr>
</tbody>
</table>

### Notes

- The table above provides a summary of electrical conductivity (EC) measurements taken at various depths in the furrow field.
- Measurements were taken 3 weeks after transplanting and at harvest.
- Changes in EC from spring to fall 2014 are also included.
- The EC values are given in dS/m.

**At harvest**

- EC values range from 0.20 to 2.85 dS/m.
- The highest EC values were observed at the 32-36" depth.
- The lowest EC values were observed at the 0-4" depth.

**Changes in EC from spring to fall 2014**

- The changes in EC range from -0.38 to 0.57 dS/m.
- The highest increase in EC was observed at the 4-8" depth.
- The highest decrease in EC was observed at the 36-40" depth.

**Field bottom**

- The EC values are relatively low, indicating a possible issue with soil quality or water management.

**Field top**

- The EC values are higher, suggesting better soil quality or water management.
RESULTS

• Furrow field: Adequate leaching towards top of field, much poorer leaching towards field bottom

• Drip field: Even with drip irrigation application volumes lower than estimated crop ET, localized leaching occurred around the drip tape (top 20 to 32 inches depending on soil texture)

• Slightly greater irrigation cutbacks with drip system did affect salinity increases somewhat

• High variability of Delta soils apparent even over short distances within the study area; soil texture and organic matter greatly affect leaching ability
SALINITY MANAGEMENT

• Leach salts out of root zone
  • Align drip tape with plant row
  • If needed, apply in-season irrigation in excess of ET
  • Winter rainfall or irrigation
• More frequent in-season irrigations
  • Easier for plant to extract water
• Apply fertilizer modestly
• Amendments (gypsum, acids)
Salinity distribution in relation to various leaching fractions

- High LF
- Low LF

Same irrigation water ECw

Soil Depth

ET

40%
30%
20%
10%

ECe

Steve Grattan, UCD
Drip Irrigation Salinity Management for Row Crops

BLAINE HANSON, University of California Irrigation and Drainage Specialist Emeritus, UC Davis; DON MAY, UCCE Farm Advisor Emeritus, Fresno County

In the past, California farmers have commonly used furrow and sprinkle irrigation to irrigate row crop plantings. More recently drip irrigation has come into increasing use in many other areas, including California’s coastal valleys and the west side of the San Joaquin Valley. Growers in some of these areas encounter high soil salinity caused either by irrigation with saline water (in the coastal valleys) or upward flow of saline ground water (in many
ACKNOWLEDGEMENTS

Michelle Leinfelder-Miles, Delta Crops Farm Advisor
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California Tomato Research Institute