Fertigation With Micro-Irrigation

Blaine Hanson
Jan Hopmans
Annemieke Gardenas
Department of Land, Air and Water Resources
University of California, Davis

Jirka Simunek
University of California, Riverside

Micro-irrigation

- Microsprinklers – trees, grapes
- Drip emitters – trees, grapes
- Drip tape – row crops

Advantages

- Relatively uniform fertilizer applications
- Flexibility in timing of applications
- Less fertilizers used
- Reduced costs

Disadvantages

- Potential contamination hazard from equipment malfunctions
- Backflow prevention devices required
- Careful handling of liquid fertilizers required

Objectives of Fertigation

- Maximize profit by applying the right amount of water and fertilizer
- Minimize adverse environmental effects by reducing leaching of fertilizers and other chemicals below the root zone
Maximizing Profit - Applying the Right Amount of Nitrogen

- Nitrogen requirements of the crop at each growth stage
- Nitrate concentrations in the irrigation water and the soil
- Amount of nitrogen in the fertilizer

What Contributes to Fertilizer Leaching Under Micro-Irrigation?

- Excessive fertilizer application
- Excessive water application
- Poor field wide uniformity of water and fertilizer applications
- Localized nonuniformity

Adjusting for Nitrogen in Irrigation Water

1 ppm N = 0.23 pounds of N per acre-inch of irrigation water

1 ppm NO₃ = 0.051 pounds of N per acre-inch of irrigation water

Calculating the Injection Rate

\[
IR = \frac{P_N \times A \times 100}{P_G \times \%C \times IT}
\]

IR = Injection rate (gallons per hour)
\(P_N\) = Pounds of nutrient per acre
\(A\) = Acres
\(P_G\) = Pounds per gallon of fertilizer
\(%C\) = Percent concentration of nutrient
IT = Injection time (hours)
What Affects the Uniformity of Fertilizer Applications under Micro-Irrigation?

- Field wide variability
  - Varying injection rate
  - Varying emitter discharge rates
    - Pressure variability
    - Clogging
    - Mixed emitters
  - Travel time of chemical in pipelines, drip lines
- Localized variability – distribution of fertilizer in the soil around the drip line

Field-wide Uniformity

- Maximum uniformity of fertilizer equals the uniformity of applied water
- Injection time must be sufficient for fertilizer to reach the furthermost part of the irrigation system
- Flushing time must be sufficient for fresh water to reach the furthermost part of the irrigation system
- Constant injection rate
Localized Nonuniformity – distribution of chemical around the drip line

- Soil water content decreases with distance and depth from the drip line
- Root density decreases with distance and depth from the drip line
- Chemical distribution may vary around the drip line, depending on chemical characteristics

Injection time = 2 hours (starts one hour after start of irrigation)
What Affects the Distribution of Fertilizer in the Soil?

- **Type of fertilizer**
  - Mobile – urea, nitrate
  - Adsorbed – ammonium, potassium, phosphorus
- **Water movement in the soil**
  - Soil type
  - Emitter discharge rate
  - Duration of irrigation
- **Fertigation strategy**
  - Duration of fertigation
  - Timing of injection relative to irrigation duration

Forms of Nitrogen

- **Nitrate**
  - Negatively charged ion
  - Moves readily through soil with water flow
  - Preferred choice of N by most plants
- **Urea**
  - Neutral molecule
  - Highly soluble in water
  - Moves readily in the soil with water flow
  - Converts to ammonium and carbon dioxide
- **Ammonium**
  - Positively charged ion
  - Adsorbed to clay particles in the soil
  - Does not move with water
  - Converts to nitrate rate at which depends on soil water content and temperature
Injection Practices

- Common recommendations
  - Inject during middle 50% of irrigation cycle
  - Inject during middle third of irrigation cycle
- Observed practices – short injection times at various times during the irrigation cycle

Fertigation Strategies

- Short injection times
  - 1 to 2 hours of injection
  - Relatively high chemical concentration in irrigation water
  - May aggravate chemical precipitation problems
  - May result in poor distribution of chemical throughout the root zone
  - Flushing highly recommended
  - Convenient for irrigators
- Long injection times
  - Middle one-third or one-half of the irrigation set time
  - Relatively low chemical concentration in irrigation water
  - May reduce precipitation problems
  - May provide better chemical distribution throughout the root zone
  - Flushing of drip lines may not be needed
  - May not be convenient for irrigators
Nitrate Concentrations

Water Application Pattern of Microsprinkler

Soil Water Content

Nitrate Concentrations
**Recommendations**

- Do not start injection until irrigation water has reached the furthermost emitters.
- Inject for sufficient time for the chemical to reach the furthermost emitters.
- After injection, flush system with irrigation water until the fresh water reaches the furthermost emitters.
- Maintain high uniformity of emitter discharge rates throughout irrigation system.
  - Minimize pressure variation (pressure-compensating emitters, pressure regulation, appropriate drip line lengths).
  - Use same emitter sizes.
  - Prevent or correct clogging problems.
- Avoid long periods of water application after injection of fertilizers or chemical.

**Other Considerations**

- **Frequency of applications**
  - Little information on effect of injection frequency on crop yield.
  - No strong trend.
- **Fertilizer-fertilizer interactions**
- **Fertilizer-irrigation water interactions**

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**Processing Tomatoes**

<table>
<thead>
<tr>
<th>Irrigation Frequency</th>
<th>Red Fruit Yield (tons/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily</td>
<td>50</td>
</tr>
<tr>
<td>2/wk</td>
<td>40</td>
</tr>
<tr>
<td>1/wk</td>
<td>30</td>
</tr>
</tbody>
</table>

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**Phosphorus**

- Do not start injection until irrigation water has reached the furthermost emitters.
- Inject for sufficient time for the chemical to reach the furthermost emitters.
- After injection, flush system with irrigation water until the fresh water reaches the furthermost emitters.
- Maintain high uniformity of emitter discharge rates throughout irrigation system.
  - Minimize pressure variation (pressure-compensating emitters, pressure regulation, appropriate drip line lengths).
  - Use same emitter sizes.
  - Prevent or correct clogging problems.
- Avoid long periods of water application after injection of fertilizers or chemical.

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**Graphs**

- **Red Fruit Yield**
  - Processing Tomatoes (weekly fertigation)
  - Irrigation Frequency: Daily, 2/wk, 1/wk
  - Yield: 50, 40, 30 tons/acre
Reactions

- Calcium-based fertilizers (CN-9, CAN-17) - can cause calcium carbonate precipitation if more than 2 to 3 meq/l of bicarbonate is in the irrigation water.
- Phosphorus fertilizers - can cause calcium and magnesium phosphate precipitation if more than 40 to 50 ppm (2 to 2.5 meq/l) of calcium and magnesium is in the irrigation water.

Reactions (continued)

- Mixing a fertilizer containing calcium with a fertilizer containing sulfate can cause gypsum to precipitate.
- Mixing fertilizers can be tricky - use jar test and UNOCAL guidelines.

Injection Equipment

- Batch Tanks
  - Inexpensive, easy to use
  - Chemical mixture becomes more and more diluted with time.
- Venturi Devices
  - Requires pressure difference
  - Inexpensive, easy to use
- Positive Displacement Pumps
  - Piston, diaphragm
  - Electric, gasoline, water-driven
  - Injects at constant rate
  - Expensive
Have a good day!!