Agricultural Water: Part 2

Introduction:
- Ag water definitions
- Distribution Uniformity

Drip irrigation:
- Design
- Key concepts

Overhead sprinklers:
- Pressure, lateral spacing, nozzle size
- Wind

Some Terms...

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow rate</td>
<td>Rate water is flowing through pipe/tape</td>
<td>gallons per minute</td>
</tr>
<tr>
<td>Tape discharge Rate</td>
<td>Rate water discharged from the tape</td>
<td>gallons per minute per 100 feet of tape</td>
</tr>
<tr>
<td>Field Application Rate</td>
<td>Rate water is applied to field</td>
<td>inches per hour pounds per square inch per 100 feet of pipe</td>
</tr>
<tr>
<td>Frictional Pressure loss</td>
<td>Pressure loss due to friction between water and pipe wall</td>
<td></td>
</tr>
</tbody>
</table>

Water volume is often expressed in units of height (inches or feet)

Example: 
- 1 acre-foot = 325,851 gallons
- 1 acre-inch = 27,154 gallons
Why Achieve Uniformity?

- Conserve water
- Minimize run-off
- Minimize percolation
- Use nutrients efficiently

Distribution Uniformity (lowest quarter)

Average application rate of lowest quarter

Average application rate

DU for drip should be > 85%
Drip irrigation Basics
ONE WORD TO REMEMBER FOR ACHIEVING UNIFORMITY:

Pressure

Sources of Pressure Variation:

Within a block
- Drip tape selection (diameter, discharge rate)
- Bed length
- Elevation change
- Polyethylene lead diameter
- Manifold/Submain diameter

Across the ranch
- Variable operating pressure among blocks
- Elevation change
- Main diameter
- System maintenance

Install Schrader valves
- Before and after filters
- Before and after pressure regulators
- Middle and end of drip line
Check pressure at Schrader valves with a high quality gauge

Typical Santa Cruz Strawberry system

DU = 71%
Drip Tape Selection

- Low Manufacturer’s “Coefficient of Variation” (CV).
  - Most are now < 3%
- Diameter: 5/8” vs 7/8” diameter
  - Bed length and emitter discharge rate
- Emitter spacing –
  - 8” often used in strawberries and vegetables
  - 12” may also work for most soils
- Low/Medium/High emitter flow rate
  - Many use high to achieve lateral movement
  - Lower flow rate allows longer beds and less manifold
  - Lower flow rate allows more acres to be irrigated at once
- Wall Thickness – many use 4 mil (cost)
  - Recommend 6 or 8 mil for hilly ground to allow higher pressures and prevent bursting of drip line
  - 10 – 13 mil for reuse or to resist puncture from insects
- Filtration
  - 120-200 mesh

Pressure Compensating vs Standard Tape

DU = 71%

5/8” diam, 4 mil, 0.67 gal/min/100 ft
2 lines per bed
266 ft
400 ft
Block 1
(50 beds)

Drip Tape

DU = 71%

5/8” diam, 4 mil, 0.67 gal/min/100 ft
2 lines per bed
266 ft
400 ft
Block 1
(50 beds)
Leads and Connectors to Drip line

5/8" diam, 4 mil, 0.67 gal/min/100 ft
2 lines per bed

Block 1
(50 beds)
268 gal/min

Main & Submain Diameter

DU = 71%
6" Main

Main and Submain Materials
Pressure Loss in Mains and Submains

<table>
<thead>
<tr>
<th>Pipe Diameter (inches)</th>
<th>Flow rate (gpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5</td>
<td>25</td>
</tr>
<tr>
<td>2.0</td>
<td>3</td>
</tr>
<tr>
<td>2.5</td>
<td>0</td>
</tr>
<tr>
<td>3.0</td>
<td>0</td>
</tr>
<tr>
<td>3.5</td>
<td>0</td>
</tr>
<tr>
<td>4.0</td>
<td>0</td>
</tr>
<tr>
<td>5.0</td>
<td>0</td>
</tr>
<tr>
<td>6.0</td>
<td>0</td>
</tr>
</tbody>
</table>

Effect of Slope along the bed

2.3 ft = 1 psi
Flush Valve to Reduce Drain Down

Slope along the Bed
- Install beds on contour (along the hillside)
- Allow no more than 1% elevation gain or 3% elevation drop along a bed.
- Keep the pressure near maximum for the tape (10 psi for most 4 mil tape)
- Use heavier tape (6 or 8 mil) – allows pressures up to 12 or 14 psi
- Use Pressure Compensating drip tape (PC tape)

Typical Santa Cruz strawberry system:

Main factors reducing within block uniformity:
- Drip tape discharge rate
- Submain diameter
- Manifold and bed slope

Uniformity Across the Ranch
- Operational Pressure
- Elevation Change
- Main diameter
- System Maintenance
Regulate Pressure of Blocks

Prevent clogging and fix leaks in drip tape:

- Flush lateral lines
- Clean filters (check backflush)
- Chemical injection
  - vinegar, bleach, other acids
- Use flow meter and visual inspection for leaks

Organic Fertilizers of Solution Grade for Fertigation*

<table>
<thead>
<tr>
<th>Organic Fertilizers</th>
<th>Solution Grade</th>
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</thead>
<tbody>
<tr>
<td>Activate, Micronized</td>
<td>Fertal Liquid Iron</td>
</tr>
<tr>
<td>Aqua Power Liquid Fish</td>
<td>Fertal Liquid MB</td>
</tr>
<tr>
<td>Azomite</td>
<td>Fertal Liquid Zinc</td>
</tr>
<tr>
<td>BioBrite Organic 0-3-5</td>
<td>HPFC Hydrolyzed Fish Powder</td>
</tr>
<tr>
<td>BioBrite Organic 0-0-0</td>
<td>Maxirop Kelp Extract</td>
</tr>
<tr>
<td>BioBrite Organic Micronutrients</td>
<td>Micro Humatoz</td>
</tr>
<tr>
<td>Crawford's Micronized Compost</td>
<td>Micro Pheo</td>
</tr>
<tr>
<td>Diamond K Solution grade Gypsum</td>
<td>Multi-Ka-Min</td>
</tr>
<tr>
<td>Earth Juice Bloom 0-3-1</td>
<td>Neptune’s Harvest Liquid Fish</td>
</tr>
<tr>
<td>Earth Juice Catalyst</td>
<td>Nutra Min</td>
</tr>
<tr>
<td>Earth Juice Grow 2-1-1</td>
<td>Omega 1-6-5</td>
</tr>
<tr>
<td>Eco-Hydro fish Liquid</td>
<td>Omega 6-6-9</td>
</tr>
<tr>
<td>Eco-Hydro Tea and Humic Acids</td>
<td>Phytoam 800</td>
</tr>
<tr>
<td>Eco-Poly 21 micro Shrimp</td>
<td>Solubor Boron</td>
</tr>
<tr>
<td>Feather Tea</td>
<td>Sulfate of Potash, Diamond K Soluble</td>
</tr>
<tr>
<td>Fertal Liquid Chelate Calcium</td>
<td></td>
</tr>
</tbody>
</table>

*Organic Material Research Institute, National Organic Program

Achieving Uniformity with Drip: Summary

Application uniformity requires--

- Even pressure
- Good operation and maintenance practices
**Distribution Uniformity with Overhead Sprinklers**

**Crop pattern caused by poor distribution uniformity**

**Improving Sprinkler Uniformity**

Where to begin?

- Pressure
- Nozzle size
- Head
- Lateral spacing
- Head spacing
- Off-set
- Riser height
- Maintenance
- Wind

**Effects of Pressure on Pumping Costs**

<table>
<thead>
<tr>
<th>Energy Cost Rate $/kWh</th>
<th>Pressure at nozzle</th>
<th>$/acre-ft</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>40 psi</td>
<td>60 psi</td>
<td></td>
</tr>
<tr>
<td>0.10</td>
<td>33.5</td>
<td>40.8</td>
<td>7.3</td>
</tr>
<tr>
<td>0.12</td>
<td>40.2</td>
<td>48.9</td>
<td>8.7</td>
</tr>
<tr>
<td>0.14</td>
<td>46.9</td>
<td>57.1</td>
<td>10.2</td>
</tr>
<tr>
<td>0.16</td>
<td>53.6</td>
<td>65.2</td>
<td>11.6</td>
</tr>
</tbody>
</table>

1. 120 ft operating depth for well, 90% efficiency motor, 72% efficiency pump
Wind Effects on Sprinkler Distribution Uniformity

Improving Sprinkler Uniformity

Start with:

1. Wind
2. Lateral spacing/head spacing
3. Sprinkler head
4. Nozzle size
5. Pressure
6. Offset