ACCOUNTING FOR SOIL PROPERTIES IN S.D.I. DESIGN AND OPERATION

Subsurface Drip Irrigation Workshop
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MAIN DRIVERS FOR SHIFTING IRRIGATION GEAR WITH ALFALFA?

#) Prospect of increased yield

#) More control on irrigation & nutrients

- Timing & amounts
- Avoidance of deficits and stress
- Excess & leach-outs

Better soil-water conditions

SPOON-FEEDING THE CROP RATHER THAN WETTING & DRYING + UNCERTAINTIES
TARGET
Unsaturated flow

Possible stress
N leaching, water logging

Possible stress
N leaching, water logging

Stressed plant growth
Too little water

Stressed plant growth
Too little water

Infiltration @ 6 hrs

Infiltration @ 12 hrs

Infiltration @ 18 hrs

Infiltration @ 24 hrs

Deep percolation – lost water & N fertilizer

Head

Rootzone

Rootzone Depth (m)

0
0.5
1.0
1.5
2.0

Root Zone

Insufficient Watering

Excessive Watering

Tail – no leaching
Gravity vs. Drip Irrigation Yield Comparison

Gravity Irrigation

Micro-Irrigation

Clay
Loam
Sand

Root Zone
OUR TARGET WITH SDI IN ALFALFA IS CHALLENGING!
KEY ADVANTAGES OF SDI:

- SHORTENING DRY-DOWN PERIODS
- SPOON-FEEDING THE ROOTS

Irrigation Threshold

Water Stress Threshold

6-20 DAYS
COMMON PROBLEMS (what we learned from Growers)

Problems subbing between laterals: 40” spacing (the most common) may not be ideal for many soil types

Over-irrigation trying to compensate for insufficient lateral water movement

How to prevent costly mistakes?
RECOMMENDED PRELIMINARY EVALUATIONS

Is the soil in our fields homogeneous or are there zones with different features?

What are the hydraulic characteristic of the different soils in your fields?

ZONING + Accurate evaluation of soil differences ($40-60/Ac)

[Diagram of soil types and data]
WHAT ARE THE MAIN ASPECTS TO CONSIDER?

**Soil hydraulic features:**

1. Soil infiltration (intake) rate
2. How does water moves in the soil
3. Vertical and lateral water movement

IS THIS ENOUGH??

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**Table 1. Recommended maximum application rates for soils of various textures**

<table>
<thead>
<tr>
<th>Soil type</th>
<th>Maximum application rate (in/hr) at slope</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0–5%</td>
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<tr>
<td>coarse sandy soil</td>
<td>1.5–2.0</td>
</tr>
<tr>
<td>light sandy soil</td>
<td>0.75–1.0</td>
</tr>
<tr>
<td>silt loam</td>
<td>0.3–0.5</td>
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<tr>
<td>clay loam, clay</td>
<td>0.15</td>
</tr>
</tbody>
</table>

*Source: NRCS 1984.*

*Note: Metric conversion: 1 in = 2.54 cm.*
Water movement through soil typically happens under:

- SATURATED CONDITIONS
- UNSATURATED CONDITIONS

In SDI WATER FLOWS MAINLY THROUGH UNSATURATED SOIL:

- Macro-pores are filled with air
- Water movement is accommodated by finer pores
- Water is under tension (suction by soil particles)
- It does not enter macro-pores, cracks and wormholes
VERTICAL AND LATERAL WATER & SALTS MOVEMENT

<table>
<thead>
<tr>
<th>Soil Texture</th>
<th>Avg. Drip Subbing Diameter (ft.) - 1 GPH</th>
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</thead>
<tbody>
<tr>
<td>Sand</td>
<td>2</td>
</tr>
<tr>
<td>Loamy Sand</td>
<td>3</td>
</tr>
<tr>
<td>Sandy Loam</td>
<td>4</td>
</tr>
<tr>
<td>Loam</td>
<td>5</td>
</tr>
<tr>
<td>Silt Loam</td>
<td>6</td>
</tr>
<tr>
<td>Sandy Clay Loam</td>
<td>6</td>
</tr>
<tr>
<td>Sandy Clay</td>
<td>7</td>
</tr>
<tr>
<td>Clay Loam</td>
<td>8</td>
</tr>
<tr>
<td>Silty Clay Loam</td>
<td>9</td>
</tr>
<tr>
<td>Silty Clay</td>
<td>9</td>
</tr>
<tr>
<td>Clay</td>
<td>10</td>
</tr>
</tbody>
</table>

Source: Blake Sanden – UC CE Kern County
HYDRAULIC CONDUCTIVITY

The rate at which water can move through the soil (cm/s; inc./s)

**Saturated Hydraulic Conductivity** occurs when all the pores of the soils are filled with water

✓ depends on the macro-pores and cracks
✓ highly variable from ft. to ft.

In SDI => **Unsaturated Hydraulic Conductivity**

✓ much less spatially variable
✓ depends on the soil matrix

**Hydraulic conductivity decreases when soil dries**

✓ air enters the soil to replace water
✓ water movement occurs only through the micro-pores
✓ flow is more tortuous and difficult
QUICK METHOD TO ESTIMATE THE HYDRAULIC FEATURES OF YOUR SOIL ($k_s$)
$w = K_1 (V_w)^{0.22} \left( \frac{k_s}{q_w} \right)^{-0.17}$

$Z = K_2 (V_w)^{0.63} \left( \frac{k_s}{q_w} \right)^{0.45}$

$w =$ wetted width or diameter (m)
$Z =$ vertical depth of wetting front (m)
$q_w =$ point source emitter discharge (L/hr)

$K_1 = 0.031; \quad K_2 = 29.2$

$V_w =$ volume of water applied (L)
$k_s =$ saturated hydraulic conductivity

<table>
<thead>
<tr>
<th>t (h)</th>
<th>q (gal/hr)</th>
<th>Vw (gal)</th>
<th>Ks (ft/hr)</th>
<th>w (ft)</th>
<th>Z (ft)</th>
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<tbody>
<tr>
<td>1</td>
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<td>0.4</td>
<td>0.28</td>
<td>0.74</td>
<td>0.88</td>
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<td>0.4</td>
<td>1.7</td>
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<tr>
<td>16</td>
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<td>1.36</td>
<td>5.05</td>
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<tr>
<td>18</td>
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<tr>
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<td>0.28</td>
<td>1.43</td>
<td>5.81</td>
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<tr>
<td>22</td>
<td>0.4</td>
<td>9.3</td>
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<td>1.46</td>
<td>6.17</td>
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<tr>
<td>24</td>
<td>0.4</td>
<td>10.1</td>
<td>0.28</td>
<td>1.49</td>
<td>6.52</td>
</tr>
</tbody>
</table>
MISCONCEPTIONS

Pulsing on-off SDI does not increase the lateral subbing

✓ instead disconnects the water flow through the micro-pores, pushing water downwards (especially in sandy soils)

✓ filling multiple times the tubings has often the effect of increasing the draining from tail-ends or in low spots

✓ decrease distribution uniformity

Surfactants only increase water penetration in the soil

✓ decrease the suction between micro-pores and water

✓ decrease the lateral subbing

✓ move more water downwards
THANK YOU!