Drip Tape Irrigation Systems

Larry Schwankl
UC Cooperative Extension
(559) 646-6569  ljschwankl@ucanr.edu

Powerpoint at:  http://ucanr.edu/schwankl
Drip Tape Irrigation Systems:

- To be covered today:
  - Application rate of drip tape.
Drip Tape Irrigation Systems:

- To be covered today:
  - Application rate of drip tape.
  - Maintenance of microirrigation systems.
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  - Maintenance of microirrigation systems.
  - Germination with drip tape.
Drip Tape Irrigation Systems:

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  - Crop water use (ET) info. given in “inches/day”.
Drip Tape Irrigation Systems:

- Application rate of drip tape.
  - Crop water use (ET) info. given in “inches/day”.
  - Drip tape discharge rate given in “gpm/100’ of tape” or “gph per emitter at some spacing”.
Drip Tape Irrigation Systems:

- Application rate of drip tape.
  - Manufacturer’s info. given in gpm/100’.

### Product Information: T-Tape Drip Tape

| Prod. Dia. | Wall Spacing | Flow Rate (per 100 ft.)* | Max. Length of Run ** | Roll Length | Item Number
|------------|--------------|--------------------------|-----------------------|-------------|-------------
| T-Tape 5/8 | 5 4          | 1.00                     | 285                   | 12,000      | 101001661   |
| T-Tape 5/8 | 5 6          | 0.22                     | 685                   | 12,000      | 101001662   |
| T-Tape 5/8 | 5 6          | 0.67                     | 375                   | 12,000      | 101001663   |
| T-Tape 5/8 | 5 8          | 0.17**                   | 790                   | 12,000      | 101001470   |
| T-Tape 5/8 | 5 8          | 0.34                     | 595                   | 12,000      | 101001471   |
| T-Tape 5/8 | 5 8          | 0.45                     | 490                   | 12,000      | 101001472   |
| T-Tape 5/8 | 5 8          | 0.50                     | 450                   | 12,000      | 101001473   |
| T-Tape 5/8 | 5 8          | 0.67                     | 375                   | 12,000      | 101001474   |
| T-Tape 5/8 | 5 9          | 0.15                     | 850                   | 12,000      | 101001669   |
| T-Tape 5/8 | 5 12         | 0.22                     | 720                   | 12,000      | 101001475   |
| T-Tape 5/8 | 5 12         | 0.45                     | 490                   | 12,000      | 101001477   |
| T-Tape 5/8 | 5 12         | 1.00                     | 285                   | 10,000      | 101008273   |
| T-Tape 5/8 | 5 12         | 0.33                     | 375                   | 12,000      | 101001478   |
Drip Tape Irrigation Systems:

- Application rate of drip tape.
  - Manufacturer’s info. given in gpm/100’.

<table>
<thead>
<tr>
<th>Emitter Model / Nominal Flow Rate</th>
<th>Wall Thickness</th>
<th>Maximum Operating Pressure</th>
<th>Inside Diameter</th>
<th>Dripper Spacing (in.)</th>
<th>Flow: GPM / 100’ @ 8 PSI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Flow 0.07 GPH @ 8 PSI</td>
<td>6 mil</td>
<td>10 PSI</td>
<td>5/8&quot;</td>
<td>6”</td>
<td>.233</td>
</tr>
<tr>
<td></td>
<td>8 mil</td>
<td>12 PSI</td>
<td></td>
<td>12”</td>
<td>.117</td>
</tr>
<tr>
<td></td>
<td>10 mil</td>
<td>15 PSI</td>
<td>7/8”</td>
<td>6”</td>
<td>.233</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>12”</td>
<td>.117</td>
</tr>
</tbody>
</table>

Cv ≤ 0.03 Emitter exponent = 0.5

<table>
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<th>Wall Thickness</th>
<th>Maximum Operating Pressure</th>
<th>Inside Diameter</th>
<th>Dripper Spacing (in.)</th>
<th>Flow: GPM / 100’ @ 8 PSI</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Flow 0.27 GPH @ 8 PSI</td>
<td>5 mil</td>
<td>8 PSI</td>
<td>5/8&quot;</td>
<td>8”</td>
<td>.670</td>
</tr>
<tr>
<td></td>
<td>6 mil</td>
<td>10 PSI</td>
<td></td>
<td>12”</td>
<td>.450</td>
</tr>
<tr>
<td></td>
<td>8 mil</td>
<td>12 PSI</td>
<td>7/8”</td>
<td>16”</td>
<td>.340</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8”</td>
<td>.670</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>12”</td>
<td>.450</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>16”</td>
<td>.340</td>
</tr>
</tbody>
</table>

Cv ≤ 0.03 Emitter exponent = 0.5
Drip Tape Irrigation Systems:

- Application rate of drip tape.
  - Manufacturer’s info. given in “gph per emitter at some spacing”.

![Flow Rate vs. Pressure Graph](image)
Drip Tape Irrigation Systems:

- Application rate of drip tape.
  - Converting from “gph/emitter at some spacing” to “gpm/100’ of tape”.

**Table 12. Flow rate in gallons per minute per 100 feet, based on emitter flow rate and spacing.**

<table>
<thead>
<tr>
<th>Emitter flow rate (gallons per hour)</th>
<th>Emitter spacing (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.10</td>
<td>0.5 0.25 0.17 0.13 0.11 0.08</td>
</tr>
<tr>
<td>0.15</td>
<td>0.75 0.38 0.25 0.19 0.17 0.13</td>
</tr>
<tr>
<td>0.20</td>
<td>1.00 0.50 0.33 0.25 0.22 0.17</td>
</tr>
<tr>
<td>0.25</td>
<td>1.25 0.63 0.42 0.31 0.28 0.21</td>
</tr>
<tr>
<td>0.30</td>
<td>1.50 0.75 0.50 0.38 0.33 0.25</td>
</tr>
<tr>
<td>0.35</td>
<td>1.75 0.88 0.58 0.44 0.39 0.29</td>
</tr>
<tr>
<td>0.40</td>
<td>2.00 1.00 0.67 0.50 0.44 0.33</td>
</tr>
<tr>
<td>0.45</td>
<td>2.25 1.13 0.75 0.56 0.50 0.38</td>
</tr>
<tr>
<td>0.50</td>
<td>2.50 1.25 0.83 0.63 0.56 0.42</td>
</tr>
<tr>
<td>0.55</td>
<td>2.75 1.38 0.92 0.69 0.61 0.46</td>
</tr>
<tr>
<td>0.60</td>
<td>3.00 1.50 1.00 0.75 0.67 0.50</td>
</tr>
<tr>
<td>0.65</td>
<td>3.25 1.63 1.08 0.81 0.72 0.54</td>
</tr>
<tr>
<td>0.70</td>
<td>3.50 1.75 1.17 0.88 0.78 0.58</td>
</tr>
<tr>
<td>0.75</td>
<td>3.75 1.88 1.25 0.94 0.83 0.63</td>
</tr>
<tr>
<td>0.80</td>
<td>4.00 2.00 1.33 1.00 0.89 0.67</td>
</tr>
<tr>
<td>0.85</td>
<td>4.25 2.13 1.42 1.06 0.94 0.71</td>
</tr>
<tr>
<td>0.90</td>
<td>4.50 2.25 1.50 1.13 1.00 0.75</td>
</tr>
<tr>
<td>0.95</td>
<td>4.75 2.38 1.58 1.19 1.06 0.79</td>
</tr>
<tr>
<td>1.00</td>
<td>5.00 2.50 1.67 1.25 1.11 0.83</td>
</tr>
</tbody>
</table>

**General formula:**

\[
\text{flow rate (gpm/100')} = \frac{\text{emitter flow rate (gph)}}{\text{emitter spacing (in)}} \times 20
\]
Drip Tape Irrigation Systems:

- Application rate of drip tape.
  - Converting from “gpm/100’ of tape” to “in/hr”.

<table>
<thead>
<tr>
<th>Lateral spacing (in)</th>
<th>Flow rate (gallons per minute per 100 ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1</td>
<td>0.10 0.14 0.19 0.24 0.29 0.34 0.39 0.43 0.48</td>
</tr>
<tr>
<td>0.15</td>
<td>0.16 0.21 0.26 0.31 0.36 0.41 0.46 0.51 0.56</td>
</tr>
<tr>
<td>0.2</td>
<td>0.22 0.27 0.32 0.37 0.42 0.47 0.52 0.57 0.62</td>
</tr>
<tr>
<td>0.25</td>
<td>0.28 0.33 0.38 0.43 0.48 0.53 0.58 0.63 0.68</td>
</tr>
<tr>
<td>0.3</td>
<td>0.34 0.39 0.44 0.49 0.54 0.59 0.64 0.69 0.74</td>
</tr>
<tr>
<td>0.35</td>
<td>0.40 0.45 0.50 0.55 0.60 0.65 0.70 0.75 0.80</td>
</tr>
<tr>
<td>0.4</td>
<td>0.46 0.51 0.56 0.61 0.66 0.71 0.76 0.81 0.86</td>
</tr>
<tr>
<td>0.45</td>
<td>0.52 0.57 0.62 0.67 0.72 0.77 0.82 0.87 0.92</td>
</tr>
<tr>
<td>0.5</td>
<td>0.58 0.63 0.68 0.73 0.78 0.83 0.88 0.93 0.98</td>
</tr>
</tbody>
</table>

General formula:

\[
\text{Flow rate} \left( \frac{\text{gpm}}{100 \text{ ft}} \right) + \frac{\text{Spacing}}{\text{in}} \times 11.55 = \text{Application rate (in/hr)}
\]
Drip Tape Irrigation Systems:

- Application rate of drip tape.
  - You now have the drip tape application rate in “in/hr”
  - Compares nicely with crop ET (inches of water use).

<table>
<thead>
<tr>
<th>Lateral spacing (in)</th>
<th>Flow rate (gallons per minute per 100 ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>0.10 0.14 0.19 0.24 0.29 0.34 0.39 0.43 0.48</td>
</tr>
<tr>
<td>14</td>
<td>0.08 0.12 0.17 0.21 0.25 0.29 0.33 0.37 0.41</td>
</tr>
<tr>
<td>16</td>
<td>0.07 0.11 0.14 0.18 0.22 0.25 0.29 0.32 0.36</td>
</tr>
<tr>
<td>18</td>
<td>0.06 0.10 0.13 0.16 0.19 0.22 0.26 0.29 0.32</td>
</tr>
<tr>
<td>20</td>
<td>0.06 0.09 0.12 0.14 0.17 0.20 0.23 0.26 0.29</td>
</tr>
<tr>
<td>22</td>
<td>0.05 0.08 0.11 0.13 0.16 0.18 0.21 0.24 0.26</td>
</tr>
<tr>
<td>24</td>
<td>0.05 0.07 0.10 0.12 0.14 0.17 0.19 0.22 0.24</td>
</tr>
<tr>
<td>26</td>
<td>0.04 0.07 0.09 0.11 0.13 0.16 0.18 0.20 0.22</td>
</tr>
<tr>
<td>28</td>
<td>0.04 0.06 0.08 0.10 0.12 0.14 0.17 0.19 0.21</td>
</tr>
<tr>
<td>30</td>
<td>0.04 0.06 0.08 0.10 0.12 0.13 0.15 0.17 0.19</td>
</tr>
<tr>
<td>32</td>
<td>0.04 0.05 0.07 0.09 0.11 0.13 0.14 0.16 0.18</td>
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<td>34</td>
<td>0.04 0.05 0.07 0.08 0.10 0.12 0.14 0.15 0.17</td>
</tr>
<tr>
<td>36</td>
<td>0.03 0.05 0.06 0.08 0.10 0.11 0.13 0.14 0.16</td>
</tr>
<tr>
<td>38</td>
<td>0.03 0.05 0.06 0.08 0.09 0.11 0.12 0.14 0.15</td>
</tr>
<tr>
<td>40</td>
<td>0.03 0.04 0.06 0.07 0.09 0.10 0.12 0.13 0.14</td>
</tr>
<tr>
<td>42</td>
<td>0.03 0.04 0.06 0.07 0.08 0.10 0.11 0.12 0.14</td>
</tr>
<tr>
<td>44</td>
<td>0.03 0.04 0.05 0.07 0.08 0.09 0.11 0.12 0.13</td>
</tr>
<tr>
<td>46</td>
<td>0.03 0.04 0.05 0.06 0.08 0.09 0.10 0.11 0.13</td>
</tr>
<tr>
<td>48</td>
<td>0.02 0.04 0.05 0.06 0.07 0.08 0.09 0.10 0.11 0.12</td>
</tr>
<tr>
<td>50</td>
<td>0.02 0.03 0.05 0.06 0.07 0.08 0.09 0.10 0.12</td>
</tr>
<tr>
<td>52</td>
<td>0.02 0.03 0.04 0.06 0.07 0.08 0.09 0.10 0.12</td>
</tr>
<tr>
<td>54</td>
<td>0.02 0.03 0.04 0.05 0.06 0.07 0.09 0.10 0.11</td>
</tr>
<tr>
<td>56</td>
<td>0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09 0.10</td>
</tr>
<tr>
<td>58</td>
<td>0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09 0.10</td>
</tr>
<tr>
<td>60</td>
<td>0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09 0.10</td>
</tr>
</tbody>
</table>

General formula:

\[
\text{flow rate (gpm/100 ft)} + \text{spacing (in)} \times 11.55 = \text{application rate (in/hr)}
\]
Drip Tape Irrigation Systems: Summary

- Application rate (in/hr) of drip tape.
  - What do **you** need to know to do this?
  1. Drip tape diameter.
  2. Drip tape emitter spacing.
  3. Drip line (lateral) spacing.
  4. Drip tape emitter discharge (gph) (or nominal emitter discharge and operating pressure).

  or

  Drip tape discharge (gpm/100’) or (nominal tape discharge rate and operating pressure).
Questions???

Larry Schwankl
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Presentation available at:  http://ucanr.edu/schwankl
Maintenance of Microirrigation Systems:

Available at:
http://anrcatalog.ucdavis.edu/
Clogging: How do you know if you have problems?

- Flow meter.
- Measure emitter discharge.

Try to anticipate problems.
Emitters:

Clogging is the greatest “threat” to emitters.
Clogging of Microirrigation Systems

Source: Physical Clogging - Particulates
Clogging of Microirrigation Systems

Source: Physical Clogging - Particulates

Solution: Filtration
Filters:

- Screen, disk, and sand media filters are all available.
- They can all filter to the same degree **BUT** they req. different frequency of cleaning
Screen filters
Clogging of Microirrigation Systems

Source: Chemical Precipitates

- Lime (calcium carbonate) and iron are the most common problems.
Chemical Precipitate Clogging of Microirrigation Systems

Water quality levels of concern:

- Calcium: pH > 7.5 and 2.0 meq/l (120 ppm) of bicarbonate

- Iron: pH > 4.0 and 0.5 ppm iron
Clogging of Microirrigation Systems

Source: Lime

Solution: pH Control (Acidification) + filtration
Dealing with Iron Precipitation:

1. Precipitate iron in a pond
Dealing with Iron Precipitation:

1. Precipitate iron in a pond / reservoir

2. Chemicals (e.g. phosphonic acid, phosphonate) may keep iron in solution.
Clogging of Microirrigation Systems

Source: Biological Sources
Clogging of Microirrigation Systems

Source: Biological Sources

Solution: Filtration (usually media filters) + Biocide
Biological Clogging

Acid may deter but not eliminate biocide chlorine copper
Chlorine

- **Sources:**
  - Liquid - sodium hypochlorite.
  - Solid - calcium hypochlorite.
  - Gas chlorine.
Chlorine:

- **Sources:**
  - Liquid - sodium hypochlorite.
  - Solid - calcium hypochlorite.
  - Gas chlorine.

- **When add chlorine source to water:**
  - Forms hypochlorous acid + hypochlorite.
  - Hypochlorous acid is more powerful biocide.
  - If pH is lower (acidic), more hypochlorous acid is present - better biocide.
pH Effect on Hypochlorous Acid Concentration

Hypochlorous Acid Concentration (%)

4 5 6 7 8 9 10

pH
Chlorine as a Biocide

- Prevent growth: 1 - 2 ppm
- Periodic injection: 10 - 20
- Super chlorination (reclamation): 500 - 1000

Test for chlorine using a pool / spa test kit
Chlorine: Injection Rates

- **Sodium hypochlorite (liquid)**
  - Example: household bleach w/ 5.25% active chlorine.

\[
\text{Chlorine injection} = \text{System flow} \times \text{Desired Cl rate (gpm)} \times 0.006 \div \text{Strength of Conc. (ppm) Cl soln (%)}
\]

- **Calcium hypochlorite (solid)**
  - 65-70% available chlorine.
  - 12.8 lbs. of calcium hypochlorite added to 100 gallons of water forms a 1% solution.
  - Use above formula.
Leaks in Microirrigation Systems

Source: Rodents
Leaks in Microirrigation Systems

Source: Rodents

Solution: Get rid of them.
Flushing of microirrigation systems:

- Silts and clay particles pass through even the best filters.
Flushed

- Silts and clay particles pass through even the best filters.
- Need to flush the system - mainlines, submains, and laterals (in that order).
Flushing

- Silts and clay particles pass through even the best filters.

- Need to flush the system - mainlines, submains, and laterals (in that order).
  - Flush laterals by hand, use automatic flushing end caps, or manifold the ends together.
Stay on Top of Your Maintenance
Maintenance of Microirrigation Systems

Predicting Clogging Problems

*What should I watch for?*

Solutions to Existing Clogging Problems

*I Have a Clogging Problem and I Want to Solve It!*

System evaluation for emission device clogging

*How do I determine if I have a clogging problem?*

Routine Maintenance Tasks

*What should I do to keep my microirrigation system running well?*

Microirrigation systems include microsprinklers for tree crops, drip emitters for trees, vines, and some row crops, and drip tape for row and field crops. Microirrigation systems apply water to the soil through emitters that are installed along drip lines and contain very small flow passages. Microirrigation systems can apply water and fertilizers more uniformly than other irrigation methods. This uniformity results in potentially higher yields, higher revenue, and reduced irrigation operating costs.

Uniformity, a performance characteristic of irrigation systems, is a measure of the evenness of the applied water throughout the irrigation system. Distribution uniformity (DU), sometimes called emission uniformity (EU), is an index that describes how evenly or uniformly water is applied throughout the field. A uniformity of 100% means the same amount of water was applied everywhere. Unfortunately, all irrigation systems apply water at a uniformity of less than 100%, and thus some parts of a field receive more water than others. Field evaluations have shown that microirrigation systems have the potential for higher uniformity than other irrigation methods. However, clogging reduces the uniformity of applied water in microirrigation systems, thus increasing the relative differences in applied water throughout a field.

The small flow passages in the emitters and microsprinklers make microirrigation systems highly susceptible to clogging. Clogging reduces the uniformity of the applied water and decreases the amount of applied water. Clogging also decreases the amount of salt leaching around the lateral line in saline soils.

http://micromaintain.ucanr.edu
Questions???

Larry Schwankl
559-646-6569 ljschwankl@ucanr.edu

Presentation available at:  http://ucanr.edu/schwankl

Maintenance website:  http://micromaintain.ucanr.edu
Subsurface drip germination
Larry Schwankl and Carol Frate
UC Cooperative Extension

A major challenge when using subsurface drip irrigation is to germinate the crop. Often, sprinklers or surface irrigation are used for germination since it is not felt that the subsurface drip tape is capable of wetting the bed adequately. This can particularly be a problem with a small seed which may be planted shallow, or with planting situations where the plant rows are on the bed shoulders while the tape is located in the center of the bed.
Subsurface drip germination
Larry Schwankl and Carol Frate
UC Cooperative Extension

The following set of time lapse photos shows that it is possible to fully wet a large (60” spacing) bed using the subsurface drip tape. It takes a long irrigation set (24 hours applying 2.25” of water) to wet the entire bed.

At the end of the presentation, we will discuss why we seemed to be successful in wetting the bed while it is frequently reported that it is not possible to adequately wet the bed for germination.
Subsurface drip germination

Summer 2013

- Tape depth = 10”
- Tape spacing = 60”
- Bed top width = 30”
- Tape flow rate = 0.45 gpm / 100 ft
- Water began at 9 AM
- 24-hour continuous irrigation
Water Running: Approx. 1:30 hrs

Seed Rows

Drip Tape 10" deep

> 15" <

Wetted Soil
Water Running: Approx. 2:00 hrs
Water Running: Approx. 2:30 hrs
Water Running: Approx. 3:00 hrs
Water Running: Approx. 3:30 hrs
Water Running: Approx. 4:00 hrs
Water Running: Approx. 4:30 hrs
Water Running: Approx. 5:00 hrs
Water Running: Approx. 5:30 hrs
Water Running: Approx. 6:00 hrs
Water Running: Approx. 6:30 hrs
Water Running: Approx. 7:00 hrs
Water Running: Approx. 7:30 hrs
Water Running: Approx. 8:00 hrs
Water Running: Approx. 8:30 hrs
Water Running: Approx. 9:00 hrs
Water Running: Approx. 9:30 hrs
Water Running: Approx. 10:00 hrs
Water Running: Approx. 10:30 hrs
Water Running: Approx. 10:50 hrs

Nearly sunset so photos discontinued for night
Next Morning:
Water Running:  Approx. 24:00 hrs
2.25” of Water Applied
Germination of Blackeyes using SDI

Wetting of bed by subsurface drip tape for germination resulted in excellent Blackeye seed germination.
Subsurface drip germination
Larry Schwankl and Carol Frate
UC Cooperative Extension

So, why were we successful in wetting the bed?

First, soil conditions always play a role in water movement. This soil is a coarse loam and appears quite sandy. Experience would say that this would be a difficult soil to get to “sub” so that you could wet the top of the bed thoroughly. Still, we were able to successfully wet the entire bed, using only a little over 2” of applied water.
Subsurface drip germination
Larry Schwankl and Carol Frate
UC Cooperative Extension

So, why were we successful in wetting the bed?

Second, and we believe importantly, the drip tape was a high flow drip tape (0.45 gpm/100’). It is felt that the greater “driving force” of the high flow drip tape allowed the bed to be thoroughly wetted, including the bed surface.
Subsurface drip germination
Larry Schwankl and Carol Frate
UC Cooperative Extension

Would it help to cycle the water on and off?

In addition to continual operation of the drip tape, we investigated “pulsing” the water on and off, a strategy often recommended. We investigated two cycling strategies – 6 hrs on / 6 hrs off and 12 hrs on / 12 hours off. Both of these cycling strategies still required 24 hours of on-time to completely wet the top of the bed.

Under the soil conditions we investigated, pulsing of the water did not improve wetting of the bed surface. It took just as much water to wet the entire bed surface whether we ran continuously or cycled the water on and off.
Subsurface drip germination

Summary

It is common to design with low flow drip tapes since it allows longer lateral lines to be used, resulting in reduced system costs.

* Length of run (Feet) calculations represent specific products only are calculated at 90% uniformity, 0% slope, and at 8 PSI.
** Wall: MI, Spacing: inches, Flow Rate: gpm/100 Ft.
Subsurface drip germination

Summary

It is common to design with low flow drip tapes since it allows longer lateral lines to be used, resulting in reduced system costs. This design practice may have a drawback though in that the low flow tape is not as capable of wetting the bed surface for germination as a high flow drip tape.

Use of a high flow drip tape should be considered if germination is a critical capability desired in a subsurface drip system. It is recommended that a field test to check for water subbing and seedbed wetting should be done because soil conditions play such a key role in water movement.
Questions???

Larry Schwankl
559-646-6569  ljschwankl@ucanr.edu

Presentations available at: http://ucanr.edu/schwankl

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