Fertigation

Dr. Juan Enciso
Associate Professor
BAEN Department
Texas Agrilife Research and Extension
Texas A&M University System
Objectives

1. Importance of Irrigation Uniformity on Fertigation
2. Inyector and inyection rates
3. Rules of injection
Irrigation systems in the LRGV

- Poly-pipe: 52%
- Earth ditches: 33%
- Gated pipe: 10%
- Drip: 3%
- Sprinkler: 2%

Laser levelled: 67%

Dr. Juan Enciso,
Associate Professor
Texas AgriLife Research & Extension,
Texas A&M University System
Subsurface drip irrigation

Requires filtering system

Dr. Juan Enciso,
Associate Professor
Texas AgriLife Research & Extension,
Texas A&M University System
Dr. Juan Enciso,
Associate Professor
Texas AgriLife Research & Extension,
Texas A&M University System
Wetting pattern shapes and fertilizer extraction

Dr. Juan Enciso,
Associate Professor
Texas AgriLife Research & Extension,
Texas A&M University System
Fertigation requires high irrigation uniformity

Dr. Juan Enciso,
Associate Professor
Texas AgriLife Research & Extension,
Texas A&M University System
Center pivot

Uniformity over 95%

Dr. Juan Enciso,
Associate Professor
Texas AgriLife Research & Extension,
Texas A&M University System
Side roll-lateral movement

Uniformity 80%

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Associate Professor
Texas AgriLife Research & Extension,
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Surface irrigation

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Associate Professor
Texas AgriLife Research & Extension,
Texas A&M University System
Earth ditches versus poly-pipe

Uniformity 50-75%

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Associate Professor
Texas AgriLife Research & Extension,
Texas A&M University System
Surge irrigation

Cotton and sugarcane

Dr. Juan Enciso,
Associate Professor
Texas AgriLife Research & Extension,
Texas A&M University System
Border irrigation-graded border

Uniformity 50%-70%

Dr. Juan Enciso,
Associate Professor
Texas AgriLife Research & Extension,
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Big gun - traveler

High Energy cost

Very portable

Dr. Juan Enciso,
Associate Professor
Texas AgriLife Research & Extension,
Texas A&M University System
Venturi injectors require a pressure differential. A booster pump is recommended

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Texas AgriLife Research & Extension, Texas A&M University System
Venturi

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Associate Professor
Texas AgriLife Research & Extension,
Texas A&M University System
Acid injection

Inject acid to lower pH to 6.5-7.0
Water high in bicarbonate

Dr. Juan Enciso,
Associate Professor
Texas AgriLife Research & Extension,
Texas A&M University System
Controlling the injected amount.

Hose on the suction of the fertilizer tank

Dr. Juan Enciso,
Associate Professor
Texas AgriLife Research & Extension,
Texas A&M University System
Rules of injection

Check for mixing and compatibility

Jar test

Best to make a small quantity to test fertilizer before preparing large batches

Dr. Juan Enciso,
Associate Professor
Texas AgriLife Research & Extension,
Texas A&M University System
Plugging potential of irrigation water

Physical Suspended solids

Dr. Juan Enciso,
Associate Professor
Texas AgriLife Research & Extension,
Texas A&M University System
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Chemical

Manganese-iron oxides sulfides
Calcium and magnesium precipitation

Dr. Juan Enciso,
Associate Professor
Texas AgriLife Research & Extension,
Texas A&M University System
Biological

- Bacteria
- Algae
- Root intrusion - buried emitter

Dr. Juan Enciso,
Associate Professor
Texas AgriLife Research & Extension,
Texas A&M University System
Plugging potential of irrigation water

Dr. Juan Enciso, Associate Professor
Texas AgriLife Research & Extension, Texas A&M University System
### Plugging potential of irrigation water

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Low</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>&lt; 7.0</td>
<td>7.0-8.0</td>
<td>&gt; 8.0</td>
</tr>
<tr>
<td>Bicarbonate (ppm)</td>
<td>&lt; 100.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iron (ppm)</td>
<td>&lt; 0.2</td>
<td>0.2-1.5</td>
<td>&gt; 1.5</td>
</tr>
<tr>
<td>Sulfides (ppm)</td>
<td>&lt; 0.2</td>
<td>0.2-2.0</td>
<td>&gt; 2</td>
</tr>
</tbody>
</table>

Dr. Juan Enciso,  
Associate Professor  
Texas AgriLife Research & Extension,  
Texas A&M University System
### Common constituents of irrigation water

<table>
<thead>
<tr>
<th>Cations</th>
<th>Anions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amonium $\text{NH}_4$</td>
<td>Bicarbonate $\text{HCO}_3$</td>
</tr>
<tr>
<td>Calcium $\text{Ca}$</td>
<td>Carbonate $\text{CO}_3$</td>
</tr>
<tr>
<td>Hidrogen $\text{H}$</td>
<td>Nitrate $\text{NO}_3$</td>
</tr>
<tr>
<td>Magnesium $\text{Mg}$</td>
<td>Phosphate $\text{PO}_4$</td>
</tr>
<tr>
<td>Sodium $\text{Na}$</td>
<td>Sulfate $\text{SO}_4$</td>
</tr>
<tr>
<td>Potassium $\text{K}$</td>
<td></td>
</tr>
</tbody>
</table>

Dr. Juan Enciso,
Associate Professor
Texas AgriLife Research & Extension,
Texas A&M University System
Plugging prevention (chemicals used)

- Chlorine
- Acid
  - Sulfuric
  - Phosphoric
  - Urea-sulfuric (NpHuric)
  - Citric acid

Dr. Juan Enciso,
Associate Professor
Texas AgriLife Research & Extension,
Texas A&M University System
Calcium and magnesium precipitation

Carbonate precipitation ➔ Plug emitter

Use of ACID to LOW pH to 6.5

Sulfuric or white phosphoric

Last third of the irrigation set time

Dr. Juan Enciso,
Associate Professor
Texas AgriLife Research & Extension,
Texas A&M University System
Acid injection

Inject acid to lower pH to 6.5-7.0

Water high in bicarbonate

Dr. Juan Enciso,
Associate Professor
Texas AgriLife Research & Extension,
Texas A&M University System
Rules of injection

Inject acids downstream

Inject other chemicals upstream of the filter ----

discontinue the application during the flushing process

Dr. Juan Enciso,
Associate Professor
Texas AgriLife Research & Extension,
Texas A&M University System
Calcium and magnesium precipitation

If there are more than 50 ppm of Ca

Phosphoric acid should not be injected
Rules of injection

Only fertigate during the middle half of the irrigation set

1/4 1/2 1/4
Chlorine

Low concentration (1 to 5 ppm)
Act as bactericide
Oxidizer of iron

High concentration (100 to 1000 ppm)
Oxidizing agent for organic matter
Disintegrate organic matter

Dr. Juan Enciso,
Associate Professor
Texas AgriLife Research & Extension,
Texas A&M University System
Monitoring soil moisture and fertilizer movement

Dr. Juan Enciso,
Associate Professor
Texas AgriLife Research & Extension,
Texas A&M University System
Future studies

Dr. Juan Enciso,
Associate Professor
Texas AgriLife Research & Extension,
Texas A&M University System
Extraction tubes - monitor leaching, soluble elements

Dr. Juan Enciso,
Associate Professor
Texas AgriLife Research & Extension,
Texas A&M University System
Arroyo Colorado

Dr. Juan Enciso,
Associate Professor
Texas AgriLife Research & Extension,
Texas A&M University System
ALWAYS fill the mixing container with 50-75% required water

When used in the mix of dry soluble fertilizers

Dr. Juan Enciso,
Associate Professor
Texas AgriLife Research & Extension,
Texas A&M University System
ALWAYS add the ingredients slowly with circulation or agitation to prevent of large, insoluble or slowly lumps
Mixing rules

ALWAYS put acid into water

Not water into acid

Water can boil and spit dangerously

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Associate Professor
Texas AgriLife Research & Extension,
Texas A&M University System
Mixing rules

DO NOT COMBINE Phosphoric acid with any calcium fertilizer

Calcium phosphates

Plug the irrigation system

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Associate Professor
Texas AgriLife Research & Extension,
Texas A&M University System
DO NOT mix sulfate with calcium

Insoluble calcium will form
Mixing rules

Extreme hard water (Ca and Mg)

Phosphates and sulfates

Insoluble compounds

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Associate Professor
Texas AgriLife Research & Extension,
Texas A&M University System
Mixing rules

**NEVER** mix or store acids and chlorine together

A toxic chlorine gas will form
Mixing rules

ALWAYS check with supplier about insolubility and incompatibility

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Associate Professor
Texas AgriLife Research & Extension,
Texas A&M University System
Estimated Daily Water Use for Grain Sorghum

Days after planting

Inches

Leaf

Rapid growth

Boot

Bloom

Grain fill

Drying

24 50 70 80 120

0.0 0.1 0.2 0.3 0.4

Estimated Daily Water Use for Grain Sorghum

Dr. Juan Enciso,
Associate Professor
Texas AgriLife Research & Extension,
Texas A&M University System
Cation-Anion Balance

Total number of cations = Number of anions

<table>
<thead>
<tr>
<th>Source of nutrition</th>
<th>Cations</th>
<th>Anions</th>
</tr>
</thead>
<tbody>
<tr>
<td>NH$_4^+$</td>
<td>8 NH$_4^+$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4 K$^+$</td>
<td>9 H$_2$PO$_4^-$</td>
</tr>
<tr>
<td></td>
<td>1 Ca$^{2+}$</td>
<td>3 SO$_4^{2-}$</td>
</tr>
<tr>
<td></td>
<td>1 Mg$^{2+}$</td>
<td>1 Cl$^-$</td>
</tr>
</tbody>
</table>

Sum of charges        16+          16-
<table>
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<tr>
<th>Source of nutrition</th>
<th>Cations</th>
<th>Anions</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO$_3^-$</td>
<td>8 K$^+$</td>
<td>8 NO$_3^-$</td>
</tr>
<tr>
<td></td>
<td>5 H$_2$PO$_4^-$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 Ca$^{2+}$</td>
<td>1 SO$_4^{2-}$</td>
</tr>
<tr>
<td></td>
<td>2 Mg$^{2+}$</td>
<td>1 Cl$^-$</td>
</tr>
<tr>
<td>Sum of charges</td>
<td>16$^+$</td>
<td>16$^-$</td>
</tr>
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</table>
Irrigation controller

Dr. Juan Enciso,
Associate Professor
Texas AgriLife Research & Extension,
Texas A&M University System
Irrigation controller with solar panel

Dr. Juan Enciso,
Associate Professor
Texas Agrilife Research & Extension,
Texas A&M University System
Dr. Juan Enciso,
Associate Professor
Texas AgriLife Research & Extension,
Texas A&M University System