Pomegranate Irrigation, Fertigation and Nitrogen Use Efficiency with Drip Irrigation

Claude J. Phene, James A. Ayars, R. Scott Johnson, Gary S. Banuelos, Rebecca C. Phene, Dong Wang, Kevin Day & Rick Schoneman
The ONLY WAY (???) to Irrigate
Decreasing Water Applied for Irrigation Without Yield Reduction Depends Mostly on the Irrigation System ability to:

- Reduce or eliminate runoff
- Reduce evaporation from soil & plant surfaces
- Reduce drainage below the root zone
- Overcome soil surface infiltration variability
- Optimize Irrigation scheduling
- Optimize Irrigation application uniformity
- Optimize Fertigation management
Research Objectives

The overall objective is to optimize water-nitrogen interactions to improve N-use efficiency (NUE) of Pomegranate and minimize N leaching losses.

a. Determine the seasonal N requirement of DI- and SDI-fertigated Pomegranate that improve NUE without yield reduction.

b. Determine the effect of three rates of real time N-fertigation of pomegranate with DI and SDI on N leaching losses.

c. Determine if concentrations of macro-, micro-nutrients and healthy bioactive compounds in soil, peel and fruits are influenced by rates of real time N-fertigation of pomegranate with DI and SDI.
Randomized Complete Block Design with Subsamples

Irrigation Treatments
- Surface Drip
- Subsurface Drip

Nitrogen Treatments
- 50% N
- 100% N
- 150% N

Five Replications
- 3.54 acres
- 18 x 12 ft. spacing

Orchard Layout & Design
Installation of Subsurface Drip Irrigation (SDI) Line at 2 Feet Depth

6 ft. spacing, 2 ft. Depth
Electro-Magnetic Flow Meters

N1 SDI DI

N2 SDI DI

N3 SDI DI

To Lysimeter Refill Tank
Solenoid Valve

Vacuum Relief Valve

Pressure Gauge & Transducer

Submain Lines to Orchard @ 4.0-ft. depth
Manifold inlet including flush valve, pressure gauge & vacuum relief valve
Computerized Control System Linked To Real Time ETc on Lysimeter Control System
799 Pomegranate trees (Pom Wonderful) planted on April 28, 2010
Trees irrigated manually by tanking weekly or as needed in 2010
Weighing lysimeter (13.12 x 6.56 x 6.56 ft.) resolution of 0.002 in. of evapotranspiration
Soil NO$_3$-N, all plots, 4/2011

Soil depth, in.

Mean N1-DI NO$_3$-N, mg/l
Mean N1-SDI NO$_3$-N, mg/l
Mean N2-DI NO$_3$-N, mg/l
Mean N2-SDI NO$_3$-N, mg/l
Mean N3-DI NO$_3$-N, mg/l
Mean N3-SDI NO$_3$-N, mg/l
Mean Tissue Nitrate-N Recovery

AN-20 Fertilizer injected at 5.8 lb N/ac./irrigation with 10 irrigations from 6/17-6/24

Date 2011

N1,SDI  N1,DI  N2,SDI  N2,DI  N3,SDI  N3,DI  MEANS

Nitrate-N. ppm

N1,SDI  N1,DI  N2,SDI  N2,DI  N3,SDI  N3,DI  MEANS

AN-20 Fertilizer injected at 5.8 lb N/ac./irrigation with 10 irrigations from 6/17-6/24
# Applied Fertilizers

<table>
<thead>
<tr>
<th>Fertilizers</th>
<th>H₂SO₄</th>
<th>H₃PO₄</th>
<th>AN-20</th>
<th>K₂T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elements</td>
<td>S</td>
<td>PO₄-P</td>
<td>N</td>
<td>K</td>
</tr>
<tr>
<td>Concentration, ppm</td>
<td>6≤pH≤6.5</td>
<td>20</td>
<td>55</td>
<td>50</td>
</tr>
<tr>
<td>Amount Applied, lb/ac</td>
<td>632</td>
<td>26.3</td>
<td>58</td>
<td>53</td>
</tr>
</tbody>
</table>

NOTE: All liquid fertilizers were applied by injection into the irrigation water.
## Pomegranate Light Interception

<table>
<thead>
<tr>
<th>Treatment Key</th>
<th>Means</th>
<th>SDI % Inc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1 SDI N1</td>
<td>16.59</td>
<td>35.4</td>
</tr>
<tr>
<td>T2 DI N1</td>
<td>12.25</td>
<td></td>
</tr>
<tr>
<td>T3 SDI N2</td>
<td>14.36</td>
<td>18.8</td>
</tr>
<tr>
<td>T4 DI N2</td>
<td>12.1</td>
<td></td>
</tr>
<tr>
<td>T5 SDI N3</td>
<td>15.65</td>
<td>35</td>
</tr>
<tr>
<td>T6 DI N3</td>
<td>11.59</td>
<td></td>
</tr>
<tr>
<td><strong>Means</strong></td>
<td><strong>13.76</strong></td>
<td><strong>29.7</strong></td>
</tr>
<tr>
<td><strong>Lysimeter</strong></td>
<td><strong>18.53</strong></td>
<td><strong>29</strong></td>
</tr>
</tbody>
</table>

* % increase from SDI over DI and from Lysimeter over SDI-N2 Mean
Evapotranspiration (ETo, ETc), Precipitation and Kc

Date 2011

ETo=37.7 in
Lys. ETc=21.0 in.
0.13<Kc<0.25
Precipitation=2.7 in.
# Pomegranate Water Balance

**NOTE:** In 2012 we will measure drainage and change in soil water content in the lysimeter and calculate the total water balance.

<table>
<thead>
<tr>
<th>Year</th>
<th>Eto.</th>
<th>Precip.</th>
<th>Irrig</th>
<th>ETc</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>49.7</td>
<td>17.3</td>
<td>1.00</td>
<td>2.10</td>
</tr>
<tr>
<td>2011</td>
<td>48.1</td>
<td>9.9</td>
<td>8.49</td>
<td>9.42</td>
</tr>
</tbody>
</table>

2011 values to October 31st only.
Lysimeter ETc adjusted for orchard spacing.
WEEDS

Surface Drip

Subsurface Drip
1. Determine the seasonal N requirement of DI- and SDI-irrigated pomegranate (2 year old trees) that improve NUE without yield reduction.

2. Determine the effectiveness of three N injection rates with DI and SDI on maintaining adequate tissue N in pomegranate.

3. Determine the effect of seasonal N injection rate with DI- and SDI-irrigated pomegranate on leaching rate of NO$_3$-N.

4. Develop fertigation management tools for the growers and present these at seminars and field days.

5. Determine if P, K, Ca, Mg, Zn, Cu, Fe, Mn, B and Se and healthy bioactive compounds are influenced by precise N fertigation with DI and SDI irrigation.
Acknowledgements

CDFA Fertilizer Research and Education Program – funding
Paramount Farming Co. – trees
Lakos – filter set
Toro – drip tubing
Dorot – valves
BCP – electrical equipment
Verdegaal --Fertilizers
The KARE & ARS support staffs & field crews
SUMMARY & CONCLUSIONS

1. In 2010, the orchard and irrigation system were installed and tested and the trees were irrigated manually by tanking.

2. In early April 2011, the soil was sampled for NO\textsubscript{3}-N and results showed that NO\textsubscript{3}-N was very low down to 4-5 ft. depth.

3. The irrigation system was turned on semi-automatic and ETc from the lysimeter was used to irrigate and fertigate the orchard uniformly.

4. Plant tissue samples indicated a rapid response to AN-20 fertigation. N, P, & K were injected at low concentrations for total amounts of 58, 26 and 53 lb/ac., respectively.

5. From 4/22 to 10/31, CIMIS ET\textsubscript{o}, precipitation, irrigation and ETc were 48.1, 9.9, 8.5 and 9.4 in. respectively. The Crop coefficient (Kc) ranged from 0.13 to 0.25.

6. In September, the mean light interception of SDI irrigated trees was 29.7% larger than that of DI irrigated trees.