Improving Pomegranate Fertigation and Nitrogen Use Efficiency with Drip Irrigation

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WHY POMEGRANATE?

• Decreased agricultural water availability
• Increased Municipal, Industrial and Environmental water uses
• Lack of microirrigation/fertigation information for Pomegranate
• Increased concerns about groundwater nitrates and nitrous oxide emissions into the atmosphere
• Demand for crops that:
  - Are drought and salt tolerant
  - Produce healthy bioactive compounds
  - Can economically replace low value crops
Objectives

Determine seasonal water and N requirements of DI and SDI young and maturing pomegranate

Determine effect of 3 N levels on maintaining adequate N level range in maturing pomegranate

Determine the effects of continuous N injection with DI and SDI on minimizing N leaching losses and nitrous oxide emissions

Develop grower-friendly N-fertigation management tools

Determine effect of N management on macro, micro nutrients and healthy bioactive compounds in fruit and juice
TORO Microirrigation, Drip In Classic with Rootguard, 0.620 in. diameter, 0.53 gph, 0.045-in. wall thickness, 18-in emitter spacing, Installed 3.5 ft. on each side of the tree row.

SDI laterals are installed at 20-22-in. depth.

Irrigation scheduling Fully automated, based on hourly ETc from lysimeter to apply same water volume as lysimeter (2.64 gal/tree/SDI irrigation and 2.84 gal/tree/DI irrigation).

Fertigation, N-P-K injected with irrigation water at rates to meet plant requirements, based on bi-weekly plant tissue analyses.
Orchard Layout & Design

Irrigation Treatments
Subsurface-SDI
Surface Drip-DI

Nitrogen Treatments
N-1 50% N
N-2 100% N
N-3 150% N

Five Replications
3.54 acres
16 x 12 ft. tree spacing

Randomized Complete Block Design with subsamples
EVAPOTRANSPIRATION AND IRRIGATION
APPLIED-- R. C. Phene

Cumulative ETc and Irrigation Water

- Cum. ETc, gal/tree
- Cum. Irrigation, gal/tree
- Cum. Irrigation, in.

Cumulative ETc and Irrigation Water, 3/13/16 to 10/9/16.
MEAN IRRIGATION BY SDI SYSTEMS

- Mean SDI, gal/tree
- Mean SDI, mm
- Poly. (Mean SDI, mm)
- Poly. (Mean SDI, gal/tree)

Time, Date

Mean Irrigation Water, gal/tree

Mean Irrigation Water, mm
FERTILIZER APPLIED (May 10-Sept. 26)

R. SCHONEMAN & C. J. PHENE

- N-pHURIC: 45.9 lb N/acre to maintain water pH between 6 and 6.5.

- N1 treatment 45.9 lb N/acre as N-pHURIC.
- N2 treatment 45.9 lb N/acre as N-pHURIC + 102 lb N/acre as AN-20.
- N3 treatment 45.9 lb N/acre as N-pHURIC + 203 lb N/acre as AN-20.

- Phosphoric Acid: 49.5 lb P/acre.

- Potassium Thyosulfate (K2T) 84.7 lb K/acre.
INJECTED POTASSIUM

- Inj. Potassium, lb K/acre
- Inj. Potassium Thiosulfate, gal K2T/acre

- Graph showing injected potassium over time from 6/7/12 to 9/27/12.
PLANT TISSUE TOTAL NITROGEN

TIME, date

Total N, %

4/26/12 5/11/12 5/26/12 6/10/12 6/25/12 7/10/12 7/25/12

DI-N1  DI-N2  DI-N3  SDI-N1  SDI-N2  SDI-N3  Lys. (SDI-N2)
Bi-Weekly **Leaf Tissue** Total N from 5/1 to 7/16

- **MEAN HIGH**—5/1/12—2.52 %
- **MEAN LOW**—6/15/12—1.33 %
- **MEAN INCREASED**—7/16/12—1.44% (N-fertig.)

April 2012---**Soil NO₃-N** (0-48 in. depth)

- **DI**—20.1 ppm (0-6 in.)→5.5 ppm (42-48 in.)
- **SDI**—10.3 ppm (0-6 in.)→5.2 p-pm (42-48 in.)

**Similar soil** sampling was done in August and will be repeated in November 2012
Pomegranate canopy cover was measured with a multispectral Tetracam camera on June 13 and July 17, 2012.

Measurements show a respective 10% and 14% increase in mean canopy cover for the SDI System over the DI System.

Canopy cover measurement of the lysimeter tree was 21% greater than the DI mean.

Additional measurements are planned for the rest of the season and will be correlated with ETc from the lysimeter and the light bar measurements to generate Kc’s.
The pomegranate canopy light interception was measured with a light bar in August 18 and September 11, 2011 and on June 15, July 3, and July 16, 2012. In the SDI treatment, the LI increased by 66% from 12.5% in 2011 to 20.7% in 2012. In the DI treatment, the LI increased by 99% from 9.5% in 2011 to 18.9% in 2012. Overall, **SDI Increased by 10% over DI**. In 2012 light interception will continue to be measured every two weeks and will be related to ETc from the lysimeter and to the Tetracam measurements to generate canopy-related crop coefficients (Kc).
Preliminary soil nitrous oxide (N$_2$O) emissions in the DI and SDI systems were measured using the static chamber method.

On 5/31/2012, N$_2$O emission rates were affected by N application rates in the DI (surface drip irrigation) but not in the SDI (subsurface drip irrigation) for all N application rates ranging from 50 (N1), 175 (N2), and 275 ppm N (N3).

Subsequent measurements indicated similar responses implying that SDI may help prevent N$_2$O emissions even at high N injection rates.

This portion of the project was funded by USDA-ARS and future research will be dependent on additional funding.
EFFECTS OF POOR QUALITY WATER ON NUTRITIONAL CONTENTS OF POMEGRANATE
Dr. G. S. Banuelos and Staff

- One-year old pomegranate trees were irrigated with saline waters ranging from 1 to 6 dS/m, 4 ppm B, and 0.25 ppm Se.

- Ca, Mg, K, P, S and Se concentrations increased in fruit, especially Se in leaf tissue (not shown).

- Vitamin C levels increased in pomegranate fruits from trees irrigated with low quality waters.

- Vitamin C and total phenolic levels, as affected by N treatments, will be carried out in 2012 on fruits from the SDI- & DI-fertigated orchard.
Effects of Water Quality on Vitamin C Level of Pomegranate

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trt 1</td>
<td>Control</td>
</tr>
<tr>
<td>Trt 2</td>
<td>&lt; 1 dS/m + 0.250 ppm Selenate</td>
</tr>
<tr>
<td>Trt 3</td>
<td>&lt; 1 dS/m + 0.250 ppm Selenate + 4 ppm B</td>
</tr>
<tr>
<td>Trt 4</td>
<td>3 dS/m + 0.250 ppm Selenate</td>
</tr>
<tr>
<td>Trt 5</td>
<td>3 dS/m + 0.250 ppm Selenate + 4 ppm B</td>
</tr>
<tr>
<td>Trt 6</td>
<td>6 dS/m + 0.250 ppm Selenate</td>
</tr>
<tr>
<td>Trt 7</td>
<td>6 dS/m + 0.250 ppm Selenate + 4 ppm B</td>
</tr>
</tbody>
</table>

mg of Vitamin C/100 G FW
Weeds in DI vs NO weed in SDI

September 26, 2012
Harvest

- Underway
- Measure
  - Size
  - Color
  - Brix
- Nutritional qualities
CONCLUSIONS

- Preliminary results have demonstrated that the high frequency SDI System has the potential to provide:
  - More efficient WUE than DI
  - More efficient NUE than DI
  - Larger tree than DI
  - Less weeds than DI
  - Lower potential for NO₃-N leaching
  - No N₂O gaseous emission compared to DI*
  - Low quality waters improved vitamin C and phenolic compounds of pomegranate
  - Improved orchard access for maintenance equipment

* Future N₂O emission research will depend on additional and/or external funding
ACKNOWLEDGEMENTS

CDFA/FREP – partial funding (3 years)
Paramount Farming – trees
Lakos – Media filter set
Toro Micro Irrig – Rootguard drip tubing
Verdegaal Brothers--Fertilizers
Dorot – Solenoid & Manual valves
SDI+-- Consulting Time & equipment
QUESTIONS?