Optimization of Water Use and Nitrate Use for Almonds under Micro-Irrigation

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Background
This study was funded to monitor soil water and nitrate movement for 2 micro irrigation systems (Drip and Fanjet). We will determine soil physical properties and almond tree root distribution, and simulate soil water movement and nitrate transport and root water/nitrate uptake. System design parameters will be optimized to minimize nitrate leaching.

Objectives
• Collect a full range of data, from both ongoing field tests and other sources, as inputs for evaluating the computer-based HYDRUS-2D simulation model as an optimization tool applicable to almond research and management.
• Evaluate and test the HYDRUS-2D model, using field data from existing fertigation trials.
• Use the HYDRUS-2D model as a system-design and event-scheduling tool to establish irrigation/fertigation guidelines for use by the growers.

Irrigation system
Two irrigation systems, Drip and Fanjet, will be evaluated, to assess water application efficiency and root water/nitrate uptake. For each irrigation system one tree was selected for detailed instrumentation for the purpose of real-time monitoring of soil – water status.

Soil Profile
The soil profile under both Drip and Fanjet systems was analysed for soil texture, bulk density and soil layering. Figure 1 shows representative soil layers and differences of soil profile between Drip and Fanjet.

Soil water content and matric potential
A total of 34 5TE Echo sensors were installed for each tree in a 3 by 3 grid pattern at different depths to monitor temporal and spatial variations in soil water content, EC, and temperature within the rooting zone. In addition, we installed four MPS1 sensors around each tree, at the 30 and 70 cm depths, to monitor temporal changes in soil water matric potential in the root zone.

Tree instrumentation
(K,Y) notation represents Cartesian coordinate system, with both X and Y representing distance (cm) for the tree trunk. For example (0, 150) denotes the location of a sensor which is 150 cm away from the tree along the Y direction. Figure 2 shows the sensor installation for both Drip and Fanjet irrigation system.

Sensor installation
Whereas the 32 sensor at the 30 and 180 cm depths were installed manually, the other 12 sensors at the 120 and 180 cm depths were installed by a newly designed installation device, using a hand-operated horizontal crank, in conjunction with a miniature camera to monitor installation progress.

Next Steps
1-Tensiometer installation
Installation of tensiometers to evaluate leaching of water and dissolved nitrates.

2-Soil hydraulic properties
Using the outflow method (Buchner funnel) the soil hydraulic properties for each layer will be measured in the laboratory (Hanson and Hopmans, 2010). Saturated hydraulic conductivity and bulk density will be measured in the laboratory.

3-Sap flow
A heat pulse sensor will be installed on both tree in Fanjet and Drip irrigation system to measure actual tree transpiration of tree for each irrigation system.

4-Modeling
The soil profile, hydraulic properties and water transport from weather station along with irrigation/fertigation rate for each irrigation system will be used as input file for the numerical model HYDRUS-2D to simulate soil water movement, solute transport and root water uptake.

References