Optimization of Water and Nitrate Use Efficiencies for Almonds Under Micro-Irrigation

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PROJECT SUMMARY

Objectives:

- To determine optimal irrigation and fertigation practices for micro-irrigation (drip and micro-sprinkler) systems and minimize leaching losses for almond by developing the HYDRUS model.
- 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 for a range of soil conditions.
- Refine and orchard test the tool, using existing fertigation rate trials.

Background and Discussion:

This multiyear project is premised on a dictum formulated by Tom Bruulsema and colleagues that optimal fertigation practice can be realized only by focusing on the "4 R's"—the right source, right rate, right place, and right time.

The final goal of this research project is to optimize irrigation management practices for micro-irrigation systems, minimizing losses of water and nitrogen (leaching), using a computer-based modeling methodology for operating micro-irrigation systems in almond orchards.

To refine the modeling tool, additional field data on soil hydraulic properties, soil texture, and soil layering were obtained, and different types of soil-water-plant-atmosphere sensors were installed allowing for continuous monitoring of soil moisture, soil water potential gradients below the rooting zone, temperature, salinity, and nitrate concentration.

The model is to encompass the complexities associated with the dynamic interactions of water, nutrients, soil, air, and root systems. It will provide orchard managers with management guidelines for tracking and predicting the flow and transport of water and nutrients throughout and below the rooting zone.

Another anticipated advantage of using this multifaceted tool will be in the form of resource conservation. It will help to minimize the loss of water from leaching and evaporation, of nutrients from leaching and denitrification, and of yield loss from water stress and salinity stress. Further, the tool has the potential to help growers and the almond industry deal with emerging regulations.

This year of study focused on the analysis of field scale soil water storage and applied irrigation water data, with the ultimate goal to assess, evaluate, and model seasonal leaching rates of water and nitrate throughout the field. Much of leaching amounts and rates are controlled by irrigation type, soil layering, and applied irrigation water relative to evapotranspiration (ET). We are trying a tree-scale water balance technique which uses spatially-distributed soil moisture and applied irrigation water measurements to infer field-scale leaching rate and its spatial variations as caused by soil heterogeneity and non-uniformity of applied irrigation water.

The combined installation of tensiometers with solution samplers below the rooting zone are the best way to measure leaching rate. Their main limitation is caused by the large uncertainty of the soil's unsaturated hydraulic conductivity. For that purpose, we are employing in-situ soil moisture and soil matric potential data to estimate the soil hydraulic properties by way of inverse modeling.

Tentatively, our data suggest that nitrate losses in deep rooted orchards like almond are likely to occur only in the winter and spring period, if any, when the soil is wet and root water uptake rates are relatively low.

Supported jointly by the Almond Board of California, Pistachio Research Board, and USDA, this model development intends to provide a valuable and specialized information and management tool.

Project Cooperators and Personnel: Maziar M. Kandelous, Patrick Brown, David Smart, UC Davis

For more details, visit

- Poster location 60, Exhibit Hall A + B during the Almond Conference; or on the web (after January 2015) at Almonds.com/ResearchDatabase
- 2013-2014 Annual Reports CD (13-PREC4-Hopmans); or on the web (after January 2015) at Almonds.com/ResearchDatabase
- Related projects: 14-PREC6- Smart; 14-HORT13-Lampinen; 14-AIR2-Smart; 14-PREC1-DeJong; 14-PREC5-Volder (Brown); 13-PREC2-Brown; 13-HORT11A-Sanden