Three-Dimensional Modeling of Water Use and Photosynthesis in Almond Orchards

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PROJECT SUMMARY

Objectives for current year:

- Implement and test a photosynthesis model in simulation system
- Collect LiDAR, gas exchange, and meteorological data needed to parameterize and run the model (Kearney almond orchard)
- Perform initial test simulations of Kearney almonds

Background and Discussion:

Field experimentation, along with intuition, has been the traditional approach used by agronomists and growers to better understand crops, and ultimately improve efficiency in production. Making robust conclusions that lead to the adoption of new practices is typically slow, as very large data sets are required in order to separate physiological effects from the high natural variability in the system of interest. Inability to rapidly vary environmental, geographical, and architectural conditions also limits the utility of field experimentation.

This project seeks to develop a robust modeling system that can be used to evaluate proposed management strategies in a virtual environment prior to field experimentation. This will accelerate the speed of innovation and add an additional layer of information to supplement data collected in the field.

Crop models have been utilized for many decades as a tool to better understand cropping systems. While models have been relatively successful in representing field/annual crops, modeling perennial cropping systems presents many considerable difficulties such as storage of carbohydrates over winter, and their complex and seasonally-varying architectures.

Our approach is to represent the full three-dimensional geometry of the canopy and associated physical processes at the leaf scale. The model outputs will be absorbed sunlight, evapotranspiration fluxes, and photosynthetic rates for every leaf and surface in the canopy, which can be easily aggregated to give whole-plant and whole-field values. The scaling up to whole field levels is made possible through the use of high performance computing methods. This three-dimensional approach allows for explicit representation of a wide range of orchard designs and management practices such as row/plant spacing, training, pruning, etc. Our overall goal is to determine optimal management practices that minimize plant water requirements without sacrificing yields.

Our primary activities for the first year will be to finish model implementation and collect the data needed to parameterize and run the model. This data includes LiDAR data to build the plant geometry in the model, gas exchange data to parameterize the leaf photosynthesis and transpiration models, and micrometeorological data needed to drive the model. We have begun collecting initial data at Kearney Ag. Station, which will be used to run some initial simulations that can be compared against lysimeter measurements of evapotranspiration.

Project Cooperators and Personnel: Ken Shackel, Bruce Lampinen, Ted DeJong, Matthew Gilbert, Eric Kent, UC Davis

For More Details, Visit

- Poster location 45, Exhibit Hall A + B during the Almond Conference; or on the web (after January 2018) at Almonds.com/ResearchDatabase
- Website: baileylab.ucdavis.edu
- Related Projects: 17-HORT22-Shackel; 17-HORT13-Lampinen