



# Assessing Orchard and Vineyard Irrigation Needs with Thermal Aerial Imagery

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*From June 29 to July 3, 2009, we conducted flights over three different permanent crops in the San Joaquin Valley: almonds, grapes, and pistachio. This work was made possible by the visit of a team from CSIC, Cordoba, Spain. The Spanish group provided the drone aircraft, cameras, and associated equipment; we provided the team that took ground-based measurements of plant water status to compare with the remotely sensed stress indicators. The equipment and dedication of the Spanish team allowed us to not only compare remotely sensed stress indicators taken at different elevations but also on different crops and different times of the day.*

On June 25, 2009, the unmanned aerial vehicle (UAV) team from Spain, consisting of Pablo Zarco, team leader, two technicians (back up pilot and computer navigator), and three graduate students, arrived in Fresno. Their first two days were spent visiting the three experimental sites and testing the UAVs and associated systems.

The first experimental flight took place over 640 acres of pistachio at AgriWorld, Inc., in Madera. There were two 320 acre blocks. On one block, the irrigation frequency of the microsprinkler system had been increased by a factor of two, resulting in a range of tree stresses across the 10 irrigation sets. The other 320 acre block was irrigated with the grower's regular frequency and, thus, used to evaluate tree stresses that would normally occur. There were two pairs of flights made; pairs referring to flights of both the UAVs with the thermal infrared and multispectral cameras. Flights were made at 1000 ft altitudes. Ground measurements were made of tree stress with pressure chambers using a team of three people, each with ATV mounted instruments. Initial inspection confirmed that all aerial sensors were working properly.

The second experimental flights were conducted on an existing almond irrigation project at the Belridge Ranch of Paramount Farming Co., Inc. There were four pairs of

flights: 10:00 am, Noon, 2:00 pm, and 4:00 pm. The flights monitored plots exposed to five different irrigation levels. There were eight replications of each irrigation regime with each replication had four monitored trees. A team of 10 technicians, each with an ATV-mounted pressure chamber, took a total of 240 individual tree measurements during each of the four pairs of flights. Initial data analysis showed a good correlation between tree stress measured with the aerial imagery and the ground-based readings.

We returned to the AgriWorld pistachio site the next day and conducted the same measurements as previously. This was done to observe differences in the spatial distribution of tree stress with the aerial imagery; to determine if the time course development of stress resulted in differences in coefficients of variation.

The fourth experimental flights took place at the Kearney Agricultural Center on grapes surrounding the weighing lysimeter. The objective was to not only observe the correlation between aerial and ground based indicators of stress but also to allow for comparison of actual evapotranspiration (ETc) made with the lysimeter and calculated ETc based on the aerial measurements of canopy temperature (the so called METRIC and SEBAL approaches).

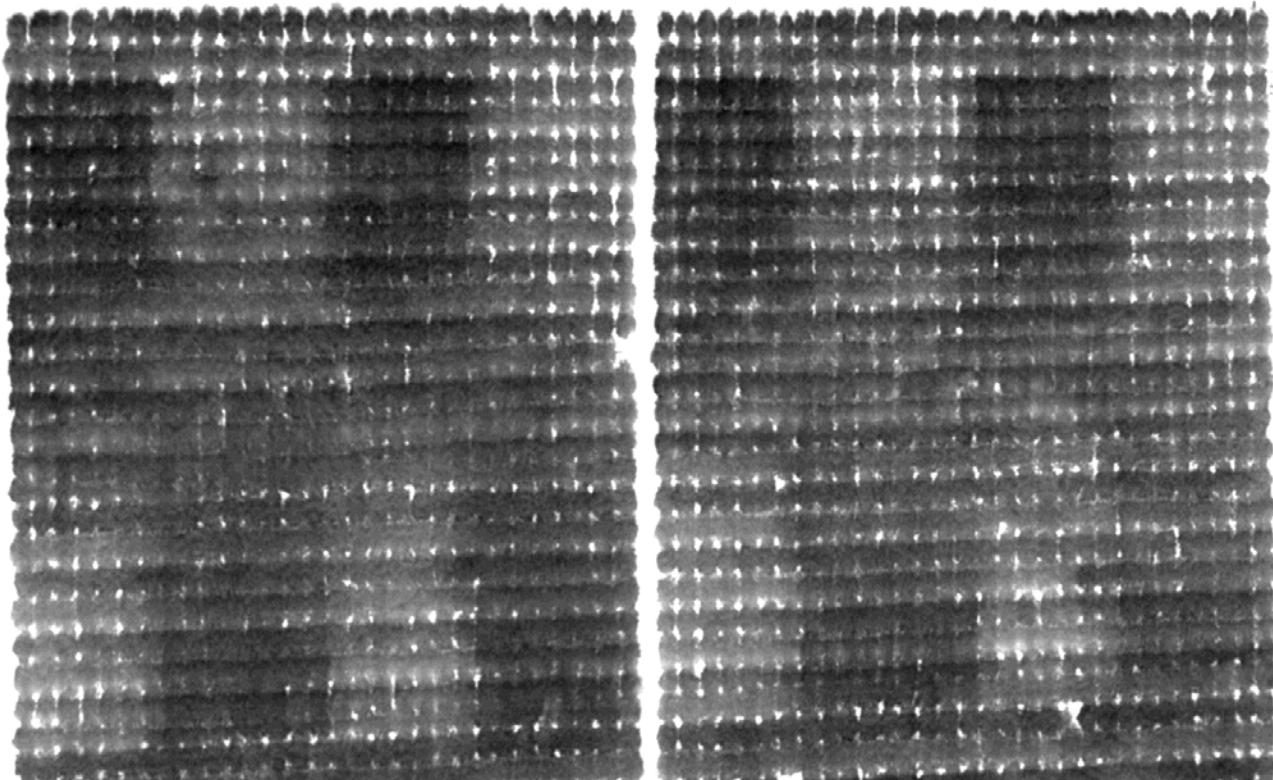


Fig. 1. Thermal aerial image (grayscale) of almond orchard with existing irrigation treatments. There are eight replications of 10 irrigation regimes on each of two cultivars (1:1 row planting configuration). In Rep. 1, treatments move from low to high irrigation from top to bottom. In Rep. 2, treatments move from high to low top to bottom and this sequence repeats itself for remaining replications. Darker pixels are cooler temperatures, lighter are hotter.

The last set of flights again took place at the AgriWorld pistachio site. In addition to conducting the same measurements as the two previous monitoring days, flights were flown at two elevations to observe differences in analysis as a function of different pixel sizes.

### **Collaborative Efforts**

The team from Spain included Pablo Jesús Zarco Tejada, Elías Fereres Castiel, José Antonio Jiménez Berni, María Dolores Suárez Barranco, Alberto Vera Toscano, David Notario Rosingana, María Victoria González Dugo. UC Davis Dave Goldhamer, Mario Salinas, and Rene Resendez, UC Davis. Kevin Brooks, UC Cooperative Extension Madera County. Richard Paisley and Chris Wiley, AgriWorld, Bakersfield.

### **Publications**

No publications have yet been published, however, a popular press article can be found at:

<http://westernfarmpress.com/environment/water-management-0805/>.

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