

# **Using Regulated Deficit Irrigation to Increase Almond Production and Water Productivity**

## **Principal Investigator**

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## **Executive Summary**

Irrigated agriculture is the primary user of diverted water in California. Traditional water conservation efforts involve improving application efficiency and making use of scientific irrigation scheduling. These approaches reduce losses due to deep percolation below the root zone of the plant and runoff from the end of the field (tailwater). However, these are usually not true water losses. Unless it moves to a salty, perched water table or flows to the ocean, water "lost" to deep percolation can be pumped and reused. Recognizing this and the fact that most California growers have become highly efficient in their irrigation management shows that there is limited opportunity to free up net water by improving application efficiency.

On the other hand, any reduction in evapotranspiration (ET) results in reduced consumptive use and a true saving of water. Since transpiration (T) is by far the largest component of ET, it needs to be the focus of any technique to reduce consumptive use. When T is decreased by water deficits, crop production in most herbaceous crops is also reduced below its maximum potential. However, a growing body of work worldwide shows that consumptive use can be reduced in orchards and vineyards without negative impacts on production and, in some cases, profits can be increased. The approach is to use regulated deficit irrigation (RDI); purposely stressing the trees or vines during stress tolerant periods of the season.

## **Almonds and RDI**

Of all crops in California, almonds offer perhaps the greatest opportunity to reduce consumptive use (total acre ft) with RDI. It's the largest orchard industry in California

involving about 700,000 mature acres with a potential ETc of at least 40 inches/yr. That translates into 2.3 million acre-ft.

There are two primary yield components in almonds; kernel size and fruit load (number of nuts per tree). Smaller kernels translate into both lower yield (assuming no impact on fruit load) and less valuable kernels as processor prices are related to kernel size. The results to date on the impacts of preharvest stress on kernel size are conflicting; some studies report smaller kernels while others do not. However, there is almost universal agreement that stress during harvest and in the six to eight weeks immediately after harvest is extremely detrimental to the following season's fruit load.

Preharvest stress has been found to accelerate the rate of hull split, which has a number of benefits to growers. It allows for an earlier harvest and processors usually pay a premium price for nuts delivered early in the season. It allows the kernels to dry more completely on the tree rather than on the ground and it's been demonstrated that the target level of 5% water content required for processing can be achieved with on-the-tree dried. Thus, the nuts could be mechanically shaken directly into catching equipment that would preclude the need to ground dry and sweep the nuts; a process that can produce excessive dust, which is a health risk. It also eliminates the possibility of fruit contamination from soil-borne bacteria, such as salmonella, and ant damage. It's also been shown that mild water stress imposed about a month prior to almond harvest not only accelerated hull split but also significantly reduced almond hull rot; a fungal disease that can cause shoot die back, ultimately reducing fruit load. Reduced vegetative growth achieved with RDI would reduce pruning and, thus, minimize agricultural burning in almonds.

We've tested a variety of RDI strategies over a four year period and found that with stress regimes that biased the stress to the preharvest rather than postharvest period, fruit load was maintained even though the trees were smaller due to less vegetative growth. While applied water was reduced by about 30% with RDI, fruiting density was significantly increased compared with the fully irrigated Control. The downside was that nut size was reduced in these RDI regimes. However, irrigation water productivity (crop production per unit of applied water) was significantly improved.

We believe that the higher fruiting densities observed with preharvest RDI suggest the possibility of alternative horticultural strategies to exploit this phenomenon in terms of both production and water productivity. We hypothesize that planting density can be increased (more trees per ha) due to the smaller tree canopies, and since fruiting density is higher, more nuts per ha can be produced using this RDI approach. This increase in nut production would offset the smaller nut size, maintaining or possibly improving nut

yields (kg/ha). This would depend on the relation between the decrease in nut size and increase in planting density. For example, if nut size was reduced using RDI by 15 % and planting density increased by 25%, nut yields would be higher.

It can't be overemphasized that grower adoption of RDI is much more likely if positive impacts on yield or yield components due to the water stress can be identified.

Widespread adoption based entirely on reduced consumptive use, even with increased water productivity, is unlikely. Moreover, RDI must be demonstrated as feasible over the long term (minimum of four year experiment) to address disease, insect, and salinity concerns.

### **Objectives**

To test whether RDI regimes that reduce seasonal consumptive use by 25-30% by imposing stress in May through July, when combined with increased planting density, can result in sustained equal or higher fruit yields than irrigation at full ETC as well as improving water productivity. Key to this work is to validate that RDI can be used to increase fruiting density (nuts per unit of canopy area). Assuming that we are successful, to provide almond growers guidelines for managing RDI and planting density to maximize production and water productivity.