Using Regulated Deficit Irrigation to Increase Almond Production and Water Productivity

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We have reduced consumptive use of mature almonds by up to 29% using RDI with only a modest decrease in kernel yield (7%), due almost entirely to smaller kernels. The goal is to eliminate any yield reduction by increasing the fruiting density of the RDI trees.

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). Unless these "losses" move to saline sinks, they are not net losses since they can be reused. 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. However, when T is decreased by water deficits, crop production in most herbaceous crops is also reduced below its maximum potential. Happily, this is not necessarily the case for tree crops. A growing body of work worldwide shows that consumptive use can be reduced in orchards without negative impacts on production. The approach is to use regulated deficit irrigation (RDI); purposely stressing the trees during stress tolerant periods of the season. Our previous RDI work with almonds using preharvest stress showed that fruit load could be maintained even though the trees were smaller due to less vegetative growth. In other words, we achieved higher fruiting density. This suggests that kernel production per unit of land could be increased while reducing the consumptive use of water.

We are testing this hypothesis in a commercial orchard located near McFarland in the southern San Joaquin Valley. The test orchard was selected since it has two planting densities in adjacent blocks; high density (21 x 18 ft) and low density (24 x 21 ft). We need to compare different planting densities since a key component of our hypothesis is that higher density trees are subject to adverse shading impacts that could reduce fruit load and that RDI could lessen foliage density, allowing more light penetration and thus, improve fruiting. The experimental orchard is planted with cv. Butte and Padre in a 1:1 row pattern. Each of four replicates is four rows wide and 39 trees long with the interior two rows used for measurements. Each replicate contains both cultivars. The cooperators' micro-sprinkler irrigation system was modified to allow us to impose preharvest stress in the RDI treatment rows. In addition to our applied water measurements, neutron probe readings are used to estimate the extraction of soil water between the beginning and end of the season that, in turn, allows for the calculation of consumptive use.

Applied water during 2006 in the high density RDI and fully irrigated Control trees was 27.2 and 37.7 inches, respectively, a 28.4% reduction. Equivalent data for the low density trees was 31.0 and 42.0 inches, respectively; 26.2% less for the RDI. Similar differences were calculated for consumptive use values. Midday shaded leaf water potential, a measure of tree stress, showed that the RDI trees were indeed stressed during much of the preharvest period relative to the Control. The

Table 1. Yield, yield component, and water productivity data for 2006.

Planting Density	Almond Cultivar	Irrigation Regime	Kernel Dry Weight (g)	Kernel Percentage (% by Wt.)	Nut Load (No./tree)	Kernel Yield 5% H2O (lb/acre)	Applied Water Productivity (lb/inch)	Consumptive Use Water Productivity (lb/inch)
High High	Butte Butte	RDI Control	0.830 a* 0.920 b	35.6 36.5	11710 11550	2502 2690	92.0 a 71.3 b	75.6 a 58.8 b
				NSD**	NSD	NSD		
Low Low	Butte Butte	RDI Control	0.775 a 0.870 b	35.1 34.6	11740 12600	2321 a 2783 b	74.9 66.3	63.8 58.3
				NSD	NSD		NSD	NSD
High High	Padre Padre	RDI Control	0.847 a 0.972 b	28.2 a 29.5 b	12470 12700	2680 a 3133 b	98.5 a 83.1 b	81.0 a 68.6 b
					NSD			
Low Low	Padre Padre	RDI Control	0.850 0.910	28.1 a 29.6 b	11970 12870	2577 2981	83.2 a 71.0 b	70.8 62.5
			NSD		NSD	NSD		NSD

* Values followed by different letters are statistically different using Fisher's LSD Method at the 5% confidence level. Statistical analysis was done between the irrigation treatments (RDI and Control) for each planting cv. and planting density.

** NSD indicated no statistically significant difference.

maximum difference between treatments was in early July with RDI and Control readings of about -2.2 and -1.2 MPa, respectively. Padre trees were slightly more stressed than Butte but the differences were consistent.

Individual kernel weight was always lower for the RDI regime, regardless of cv. or planting density (Table 1), with mean reductions of about 10%. Kernel percentages were lower for the RDI trees only with the Padre and by an average of about 4%. Nut loads were not significantly different between treatments for either cv. or planting density. However, the differences between irrigation regimes were less for the high than low density trees. This seems to support our hypothesis. Kernel yields were lower for the RDI treatments due mostly to the aforementioned smaller fruit. The least reduction occurred in the high density Butte (7.0% lower than the Control) and the most in the low density Butte (16.6% lower than the Control).

The high density plantings with RDI for both cvs. had higher applied and consumptive use water productivities relative to the Control. High density applied and consumptive use water productivity was about 29 and 18% better than the Control for the Butte and Padre cvs, respectively.

It is not possible to draw conclusions with a single year of data. However, we are encouraged that fruit loads are being maintained in the RDI trees while water productivities are higher.

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