

DRAFT DROUGHT TIP **AUGUST 2015**

Drought Strategies for Table and Oil Olive Production

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Olive (*Olea europaea* L.) is drought tolerant and trees can survive on shallow soils with little supplemental water beyond winter rainfall. In California, commercial productivity of olives relies upon irrigation to maximize fruit yield and quality. Olives grown for table consumption must achieve maximum fruit size and yield, while olives grown for oil must maintain high yields without sacrificing oil quality. When olive trees are properly irrigated, trees will respond by maximizing shoot growth, crop set, fruit size, or oil content.

Olive tree development and water use

An understanding of critical periods for water availability to olive trees is important for strategizing in times of water shortages. Olive flower buds are formed beginning approximately two months before bloom, from mid-March to mid-May. This is an essential period for water availability in olives. Lack of water during flower bud differentiation affects the timing of bloom, number of blossoms, and the percentage of blossoms that are self-pollenating (Hartmann and Panetsos 1961). Olive shoot growth begins in the spring (between February and April) and through September if water is adequate. Shoot growth is important because next years' crop will be borne on those one year old shoots. Too little water can inhibit shoot growth and reduce the crop set and yield in the following growing season (Goldhamer et al. 1993). Adequate water between August and harvest is necessary to produce larger and more profitable table olives (Goldhamer 1999). In contrast, fruit size is not critical in olives destined for oil, however it is important to boost oil content in the fruit to maximize flavor. Research has shown this is best achieved by withholding some water during fruit development (Berenguer et al. 2006).

Irrigation management using evapotranspiration (ET_c)

Research into irrigation management of olive trees has shown the use of crop evapotranspiration (ET_c) is reliable to calculate the trees' water needs throughout the growing season. ET_c is a measure of the amount of water lost from evaporation from the ground plus the amount of water transpired by the tree. ET_c varies depending on the weather conditions, including temperature, humidity, and wind, as well as day length and orchard canopy cover. The goal when using ET_c to irrigate is to replenish the soil with the same amount of water lost to evapotranspiration – essentially to irrigate at levels that match the trees' needs under the current weather conditions. This is the goal for effectively irrigating table olives to maximize production and value. Optimum oil yield and quality can be achieved by irrigating less than full ET_c.

ET_c is calculated using a reference ET level (ET_o) calculated using a reference grass crop. Real-time ET_o data are measured by CIMIS stations around the state and are available online at

www.cimis.water.ca.gov. Multiplying ET_0 by a crop specific conversion factor (K_c) will give the crop's ET (ET_c):

$$ET_c = ET_0 \times K_c$$

The K_c for olive trees is 0.75 in a clean cultivated orchard with 60% or greater shaded area (Goldhamer et al. 1994). Once the ET_c for a specific time period is calculated, the proper amount of water can be applied to each tree. Average olive ET_c for the Sacramento Valley and San Joaquin Valley are shown in Table 1. During winter months, rainfall may help fulfill the majority of the trees' water requirements. Auguring a hole at the beginning of the irrigation season will help determine the wetted depth and guide when irrigation should begin.

Table 1. Olive water use (ET_c) in inches for mature trees in a clean, cultivated orchard with 60% or greater shaded area (Beede and Goldhamer 2005).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sacramento Valley	0.92	1.22	2.14	3.41	4.60	5.51	6.36	5.47	4.07	2.69	1.19	0.75
San Joaquin Valley	0.78	1.22	2.49	3.68	5.00	5.81	6.35	5.51	4.09	2.60	1.12	0.60

Irrigation run times can be calculated for the irrigation system type installed in the orchard. Irrigation management can be very effective using ET_c , assuming the irrigation system application rate is known (inch/hour or gallons of water/tree/hour) and diligence in following the current ET_c demands. Irrigation system upkeep is also vital to ensure distribution rates are uniform across the orchard, so each tree is receiving the expected amount of water.

Deficit irrigation is the practice of irrigating a crop at less than the trees' full ET_c . Regulated deficit irrigation (RDI) refers to a practice whereby water is withheld from the trees at a specific time during the growing season. In both oil and table olives, RDI strategies can be used to lessen the impact of drought and limited water on olive quality and yield. Be aware, however, that eventually water in excess of the water holding capacity of the soil will need to be applied (either through extra irrigation or rainfall) to leach soluble salts from the soil profile, especially if deficit irrigating with high saline groundwater.

Table olive irrigation management under water shortages

The key to optimizing profits in table olives is obtaining both large fruit sizes and high fruit yields. When water is not a limiting factor, table olive size and yield can be optimized by irrigating at full ET_c (approximately 36-41 acre-inches/ acre/ year). The seasonal evapotranspiration may vary by orchard depending on tree size, light interception, and orchard floor vegetation. Ineffective weed control will lead to increased evapotranspiration within an orchard. Efficient weed control is especially important during drought conditions.

Regulated deficit irrigation (RDI) approaches may be used when a full water allocation is not available. The degree and best timing for RDI in table olives depends on the amount of water available.

When 80% or more of the full crop ET_c is available, a moderate RDI irrigation strategy will conserve water while simultaneously protecting fruit size and yield. Irrigate at full ET_c until June, then irrigate at only 50% ET_c until mid-August (Figure 1). During this period, crop and shoot growth will slow relative to the growth observed on a fully irrigated tree. Reapply water at the full ET_c after August 15th. As the trees' water needs are met, olive fruit size will rapidly increase. Goldhamer (1999) found that irrigating using a moderate RDI approach will use approximately 21% (7 to 8 acre-inches/ acre) less water without compromising fruit size, yield, or gross revenue.

When 60 to 80% of the full crop ET is available, a severe RDI strategy may be imposed. The severe RDI scheme will use approximately 40% (14 to 16 acre-inches/ acre) less water; however that water savings will be accompanied by approximately 10% reduction in yield and 25% reduction in gross revenue potential because of reduced fruit size. To impose severe RDI, irrigate at full ET from the beginning of the season until May 15th. Irrigate one month at 50% ET (May 15 until June 15), then two months at 25% ET (June 15 until August 15), followed by one month at 50% ET (August 15 to September 15), before increasing back to full ET requirements (Figure 1). Using a severe RDI approach will optimize profits at this level of water availability; however, multiple years at this level is not sustainable, as shoot growth and subsequent seasons' crop will suffer (Goldhamer 1999).

Water allocation:

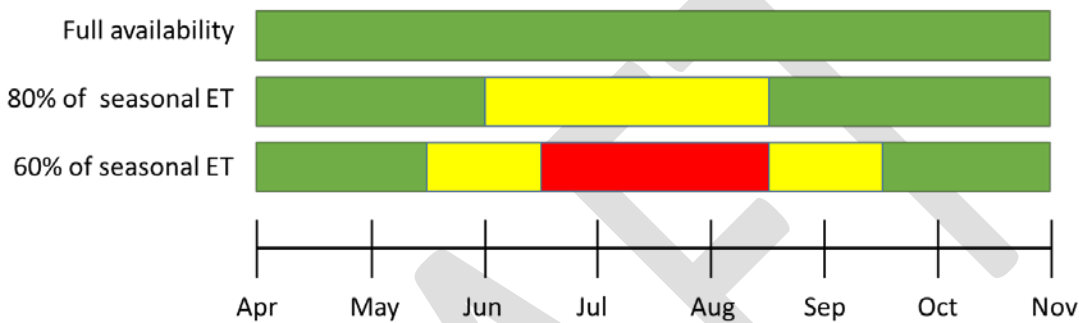


Figure 1. Timing of RDI regimes in table olives. Green bars indicate irrigation levels at 100% of the ET_c. Periods with yellow bars should be irrigated using 50% of the ET_c. Time periods with red bars should be irrigated at 25% of the ET_c.

When less than 60% of full crop ET is available, severe effects to orchard growth and productivity can be expected. One strategy is to consider irrigating with an eye towards harvesting for oil production instead of table production; however, economically this is likely not a long term (multiple season) strategy. Be sure to focus on weed control to ensure that maximum water is available to trees. Plan on 2 years of normal irrigation before orchard production returns to pre-drought levels.

Oil olive irrigation management under water shortages

The key to optimizing profits in super high density olive groves relies on producing optimum oil yield with the best flavor and quality characteristics while minimizing excess vegetative growth. Olives grown for oil do not need as much water as table olives. Oil yield and quality can be optimized by supplying enough water to match 70% of seasonal ET_c (25 to 29 acre-inches/ acre). ET_c in oil olive groves may exceed 29 inches; however, too much water and fertilizer will cause super high density orchards to produce strong vegetative growth that will shade out the lower fruitwood and reduce bloom. Excessive vegetative growth is also undesirable for over-the-row harvesters utilized in super high density olive production because of interference with the harvester and increased damage to the olive trees.

Oils produced from over-irrigated or water stressed trees may meet “extra-virgin” standards; however, oil quality is greatly affected by tree water stress levels. Fully irrigated or over-irrigated oil olives have lower levels of oil extractability and result in bland oil with less of the fruity, bitter, and pungent flavors that are desired. On the other end of the spectrum, olives from severely water stressed trees result in oils that are excessively bitter and pungent (Berenguer et al. 2006).

In oil olives, controlled deficit irrigation maintained from May through September did not have significant negative economic effects. Some of the highest quality oil can be obtained by irrigating as low as 40% of the full ET_c , although at this level, yield will begin to suffer. By balancing oil quality and yield, an optimal range for irrigating oil olives is at 40 to 70% (14 to 29 acre-inches/acre) of the full ET_c . Trees maintained at the upper end of the range (70%, or 29 acre-inches) will have higher production, while trees maintained at the lower end of the range (40%, or 14 acre-inches) will have better oil quality (Grattan et al. 2006).

Summary

In olive trees, water stress impacts tree shoot growth, flowering timing, olive fruit size, and oil quality. Depending on whether the olives are grown for table or oil olives, irrigation strategies change. Table olive growers must focus on fruit size and yield. RDI regimes can be successfully applied in table olive orchards to maintain revenue while also saving approximately 20% water over a fully irrigated tree. Severe RDI may save 40% of water use over the season, although gross revenue will suffer and orchard production is not sustainable over the long run. Oil olive growers can focus on production and oil quality. Optimum olive oil yield and high quality oil can be produced when trees are irrigated at a level between 40 and 70% of full ET_c . Even if water restrictions only permit irrigation at 30% of tree ET_c , a high quality oil may still be obtained in super high density olive orchards although total oil yield will be reduced.

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