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Water Conservation Strategies for California Groves

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Abstract. **After five years of drought and rising water costs, California farmers have voluntarily adopted growing methods that conserve water: Installation of low volume irrigation systems, irrigation during night hours, and curtailment of non-essential water uses. Now California growers face mandatory reductions of 25 to 50% or more in most areas. To remain in the business of fruit farming, growers need to achieve this reduction in water use and still maintain an adequate yield.**

This paper is specifically designed for California growers and is intended to guide them through some of the options available in order to achieve a maximum reduction in water use. However, the information presented should be useful to all in the fruit production business as it examines irrigation management, grove thinning and stumping, topworking to new varieties, mulching and weed control, and the use of antitranspirants as water conservation strategies.

How Much Water Do Your Trees Need?

In these times of drought and massive water cuts, the question of how much water avocado trees need to perform normally has been discussed at many grower meetings. Most growers know about the California Irrigation Management Information System (CIMIS) (Snyder *eta/.,* 1985), but many feel threatened by the complexity of calculations used to determine tree water use and would prefer to simply water on a fixed schedule. In an attempt to help growers use the information available to them through CIMIS, the authors have written this step-by-step guide. The aim was to simplify some of the calculations needed to use CIMIS so that growers will better understand their trees' water needs.

Most water districts in Southern California have a local monitoring station which scientifically measures the daily water use of a small plot of turf. From these plots, each station provides a daily water use value, which is the basis of the CIMIS system statewide. This value is called the reference evapotranspiration (ETo), and is the amount of water used by the turf plot on a daily basis in centimeters. This value can be used to accurately predict the water use of any crop grown locally, using a few

calculations. We have done these calculations for growers and included them in this paper as Figs. 1, 2 and 3 so they can be easily used to determine daily water use of avocado trees.

In order to use CIMIS, we recommend the following steps:

Step 1. From your water district, obtain the local telephone number to call, to learn the daily reference evapo-transpiration (ETo) value. This value may also appear in the local newspaper.

Step 2. It is necessary to approximate the percentage canopy cover of the grove. At mid day walk out to your trees. Approximately how much of the ground is shaded (or what is the size of the tree canopy cover) on a percentage basis? Figures 1-3 have been drawn for three canopy covers. These correspond to the following categories: (i) Young trees - 25% of the ground shaded; (ii) Midsize trees - 50% of the ground shaded; and (iii) Mature trees - 75% or more shaded. You must decide which canopy cover best approximates your grove.

Step 3. Choose the correct monthly chart according to the date. Note that several months are on the same chart. This is because the calculations are the same for these months. Using the ETo value for that day from the water district or newspaper, read up from the base of the chart to the correct curve (according to your % canopy cover) and across to the liters per hectare per day. For example, if the Eto value on June 23 was 0.16, and you have 50% canopy coverage; using the chart for June, your trees required about 23,463 liters of water per ha.

Step 4. Once the approximate amount of liters of water per ha needed for that day is known, it is easy to calculate the amount of water required by individual trees. Do this by dividing the liters per ha by the number of trees per ha. In most groves this is 250 trees per ha. As an example, with the 23,463 liters per ha from the chart; divided by 250 tree per ha = 94 liters per tree.

Step 5. The final step is to calculate the duration of the irrigation cycle. To do this, the output of your drip emitters or sprinklers (in liters per hour) needs to be known. As an illustration, if your sprinklers have been rated 38 liters per hour, then the 94 liters calculated in the example above will be delivered in 2 hours 30 minutes of irrigation-on-time. Make sure to account for multiple sprinklers or drip emitters per tree if you have them.

Step 6. Most growers irrigate every 4 to 7 days or more. Add up the run times for each day as calculated above and then irrigate for the total time.

These curves in Figs. 1-3 were calculated using some assumptions. The first assumption is that 10% of the water applied is used to leach out salt from the root zone, and is not for tree uptake. If excess salt burn is evident on the leaves, then salt buildup in the soil may require an additional amount of irrigation water for leaching. Secondly, the irrigation system is 80% uniform. Irrigation uniformity is very important for efficient irrigation scheduling. In California, growers may call their local Resource Conservation

District and schedule an appointment with the mobile irrigation laboratory to do a free uniformity test at their property. If their system has a uniformity below 80%, then the lab will make recommendations to bring the system up to this efficiency.

The methods the authors used to calculate the curves to determine water use per ha are based on data and methods used in the Corona irrigation experiment currently being conducted by the research workers at the University of California (Meyer *et a*/., 1992).

During flowering in avocados where the flower stalks are 2.5 cm out of the buds, and until the fruit are 1.25 cm in diameter, irrigate according to the June/July chart. Flowering is a critical time in avocados. The trees have a huge floral surface through which water is lost during flowering and fruit set. This is at a time when Santa Ana winds are common in Southern California and tree stress can devastate yields. Always get the weather forecasts during flowering and start your irrigating the day before Santa Ana conditions are expected.

Fine-tune your irrigation techniques using tensiometers. The methods above will give you a good estimation of the total water requirements, but always double check your particular grove situation using tensiometers. For a 30 cm tensiometer in a typical, irrigated section of the root-zone, irrigate avocados at 25 cb.

Now that the trees are being irrigated correctly, how can we achieve a quick reduction in water usage?

Cutting Back Orchard Water

1. Cap off all sprinklers on diseased and damaged trees. Trees suffering with root rot, black streak, and severe frost damage should not be irrigated. If border trees are subject to wind and do not bear fruit, sprinklers on these trees can be capped. An alternative may be to topwork border trees to 'Bacon' or 'Zutano' for pollinating purposes, and put these trees on a low volume irrigation schedule - just enough for the trees to flower but not to fruit.

2. Stump canopied avocado trees. Trees not thinned by the 10th year may have canopied; stump to 1.2 to 1.8 m, whitewash immediately (with a 50:50 water:water-based latex paint) for sunburn protection and allow to regrow. Stump in alternate hectare blocks; stump remaining trees in 3 years (after fruiting resumes in the initial stumped trees). Don't cap sprinklers in stumped groves; however, irrigation frequency can be greatly reduced.

3. Thin crowded groves before they canopy. For trees that have grown into each other, but have not yet canopied, we recommend thinning (the removal of every other tree). The sprinklers at thinned trees can be capped; achieving an instant reduction (30-40%) in water usage.

4. Topworking as a temporary conservation measure. Topworking avocados (to 'Hass') will be excellent for temporary water conservation. This may be a good time to establish more desirable varieties in your grove.

5. Mulching and weed control do work. Mulching with straw (especially on younger trees) may reduce evaporation from the soil surface. A grove with a stand of weeds may use 25% more water per year than a grove without weeds.

6. Antitranspirants - water conservation for the future?

These are generally polymers, plastics, or latex leaf covers. They are sprayed on as water-based sprays that become waterproof once dry. Their effect is to reflect sun, reduce leaf temperature, and reduce leaf water loss. Net water savings, and the long term effect on the trees remain unclear. In a trial conducted on eight-year-old 'Hass' avocados in spring, 1991, the authors concluded that the most common anti-transpirant formulations were not effective in water conservation using current irrigation management techniques (unpublished data).

Summary of Conservation Methods

1. Use CIMIS to save water, time and money.
2. Cap off sprinklers on diseased and damaged trees.
3. Stump canopied avocado trees.
4. Thin crowded groves before they canopy.
5. Topwork to desirable varieties and achieve a temporary water saving.
6. Mulching and weed control will both reduce soil water loss.
7. Consider antitranspirants; perhaps try a couple of products on a small scale. Current experimental data, however, shows no clear water saving using these products on avocado trees.

Literature Cited

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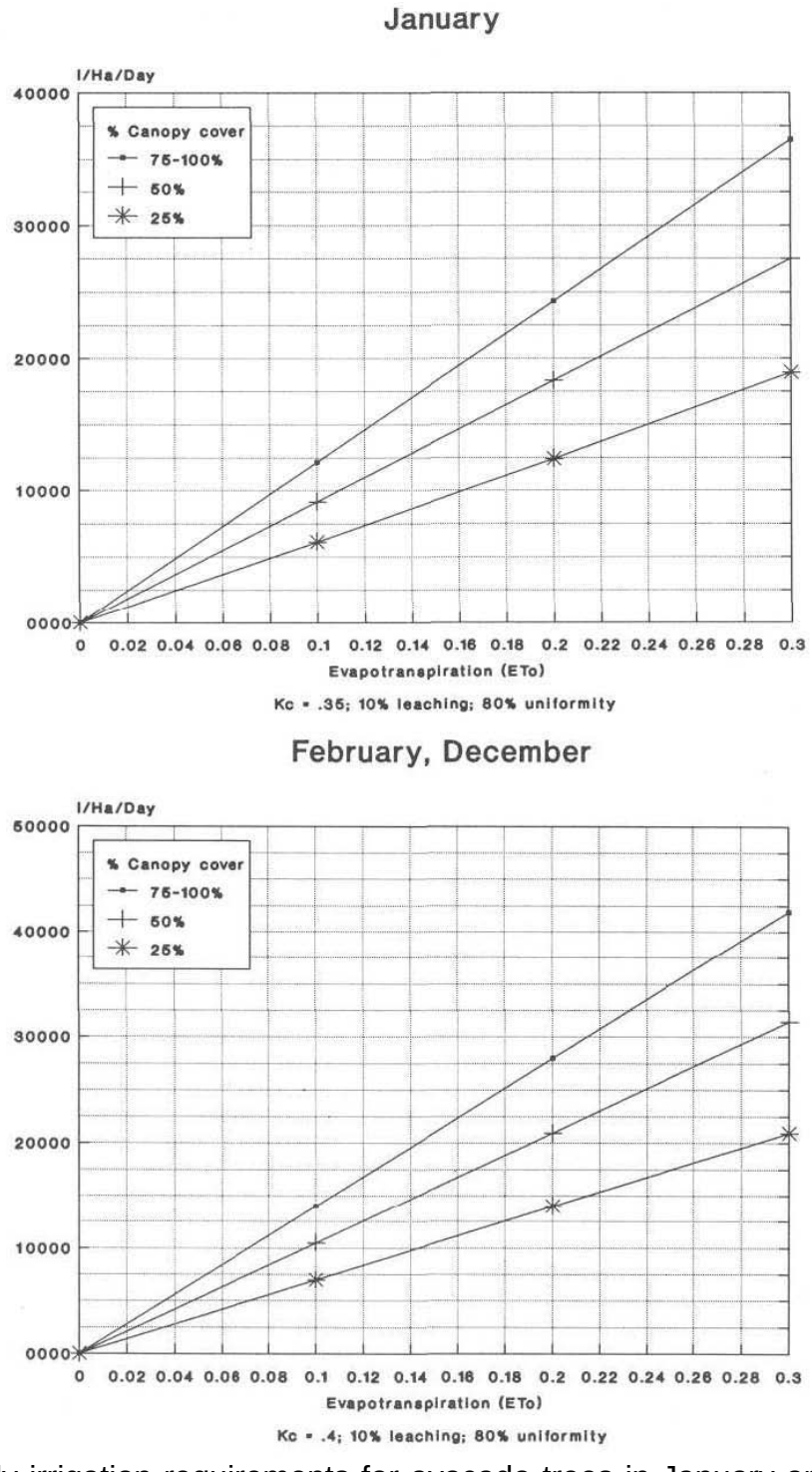

Figure 1. Daily irrigation requirements for avocado trees in January and February and December. Kc = crop coefficient; 1 liter/ha/day = 0.1065 gal/acre/day.

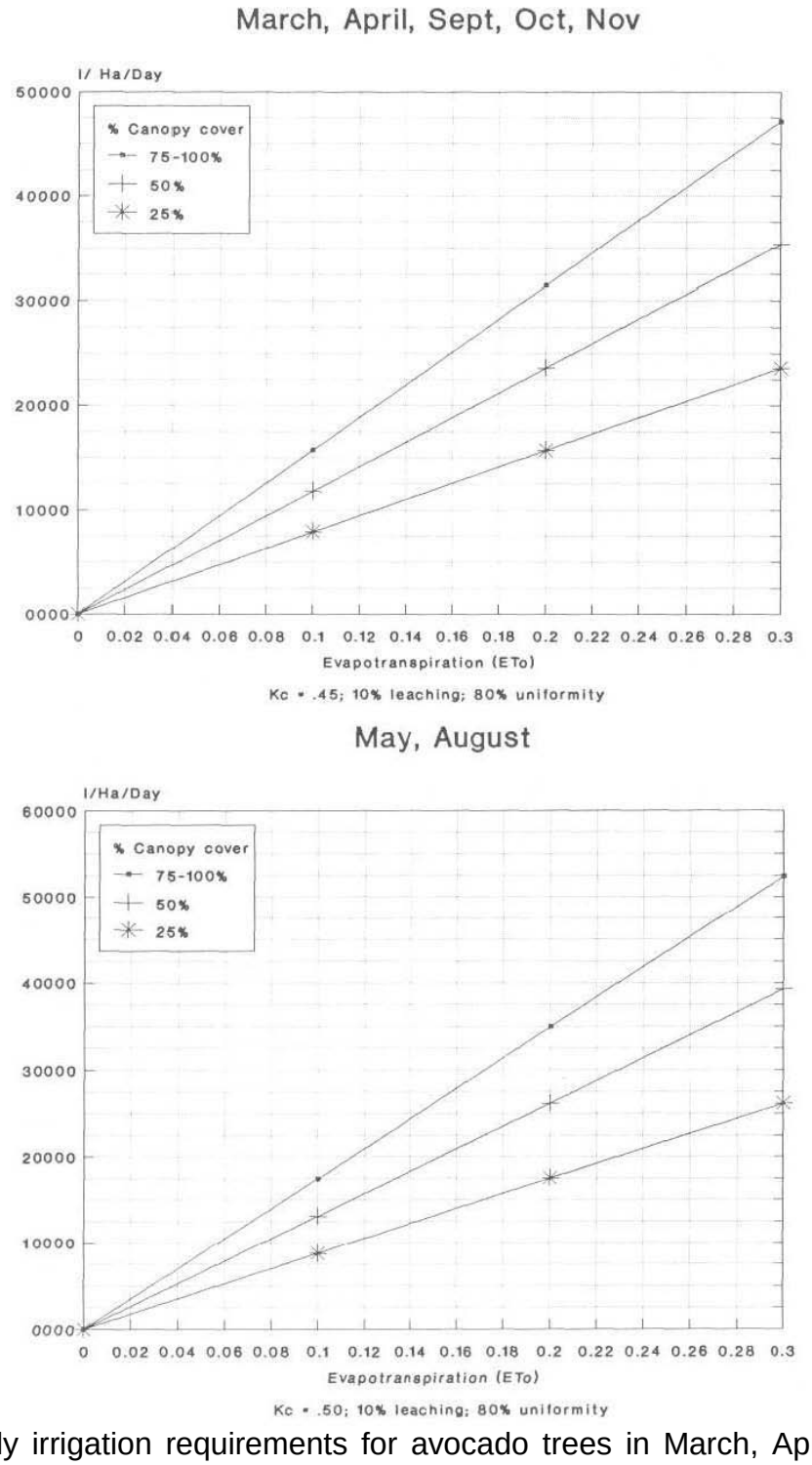

Figure 2. Daily irrigation requirements for avocado trees in March, April, September, October, and November and May and August. Kc = crop coefficient; 1 liter/ha/day = 0.1065 gal/acre/day.

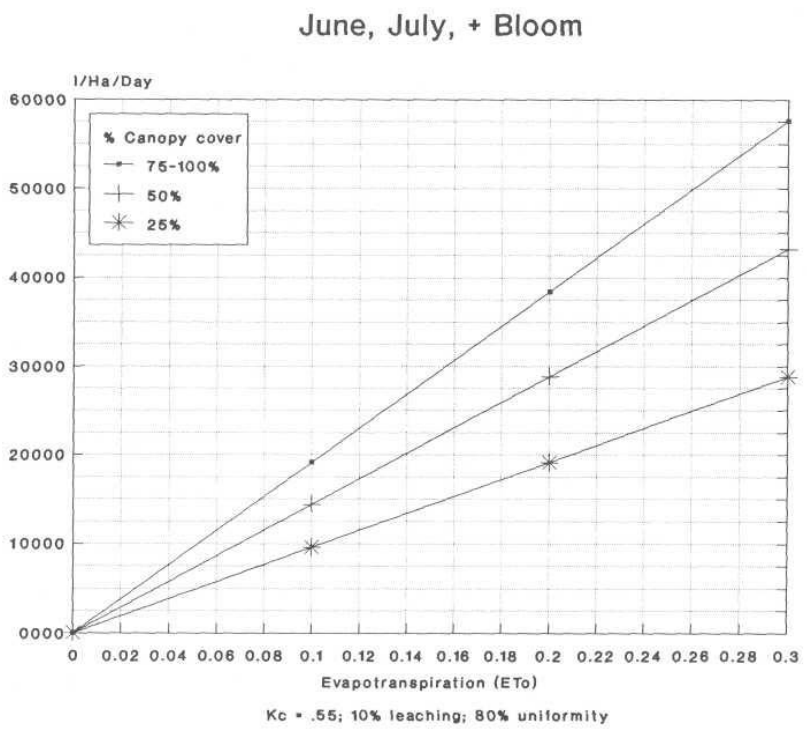

Figure 3. Daily irrigation requirements for avocado trees in June and July. Kc = crop coefficient; 1 liter/ha/day = 0.1065 gal/acre/day.