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Kern Citrus and Subtropical Fruit

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While my experience with citrus is relatively short compared to many of the senior members of our industry who grew up with it, certainly, these are the worst drought conditions that I have ever seen. Short of a miracle March, which appears to be fast fading, I don't see a way out of this predicament. The options, generally, appear to be grim or grimmer.

What is the worst case scenario? I once worked for a large commercial citrus company that abandoned a block of oranges near Famoso, California. The oranges received no irrigation other than what rain fell. By the following spring, most, but not all of the trees appeared to have survived, but as one can imagine they weren't very pretty to look at. Besides the actual leaf and fruit loss that a lack of water will cause, a mature citrus tree that loses its canopy, is extremely prone to sunburn, and attack by secondary fungal and insect pathogens.

So what are the options of dealing with a situation where the grower only has a small percentage of the water necessary to grow a mature crop of citrus?

Options for Dealing with Reduced Water Allocations

The option for one grower who owns an aged, mid-season orange grove that the fruit does not hold particularly well on, is to remove the orchards since he hasn't nearly enough water to farm it. Newly planted citrus use a lot less water than mature trees, probably less than 5% or so of mature trees if drip irrigated when first planted. This choice appears sound.

Several growers in local irrigation districts have been notified that they will receive half of their normal water delivery. While this situation is far from ideal, it is certainly better than the allocation many districts will be able to deliver. Some districts are able to deliver this amount of water, largely as a result of the foresight of those that saw the need to establish underground water banks in the area. What are the options for farming with the information, at this time, that you have only 50% of the water allocation necessary to grow citrus?

An optimistic grower with a tolerance for risk, experiencing this situation of a 50% delivery, might assume that through unexpected large precipitation events or change in water-delivery policies that there will be plenty of water available later in the season, and he or she can go ahead and irrigate at full crop ET. This strategy brings to mind an incident at a water district office in the early 1990s that I was unfortunate enough to witness, where a grower actually wept when informed that his water allocation had been exhausted mid-season, and not more water would be forthcoming.

So what other options might be available for irrigating only 50% of normal besides gambling or orchard removal? What does research tell us?

Regulated Deficit Irrigation Research

In data reported from 1998 – 2000, Dr. David Goldhamer, a U.C. Cooperative Extension Specialist, researched regulated-deficit irrigation in navel orange (specifically, a mature block of 'Frost Nucellar' on Troyer Orange rootstock) near the town of Famoso in Kern County. Optimal citrus production not only involves overall yield of fruit, but the quality of the fruit. For example, fruit size plays an important role in grower returns. This study was extensive, and included 14 deficit irrigation treatments. Eleven of these treatments were during the active growing season for periods of 4 to 9 weeks and involved water application rates from 0 to 50% of the fully watered control. While Dr. Goldhamer found a fairly strong relationship between gross yield and applied water, there was no relationship between the amount of applied water and gross revenue, fruit load, and packable cartons (i.e. fancy and choice) for any of the treatments compared to the control. Frost Nucellar navel oranges can have a problem with puff and crease which deficit irrigation seems to reduce. Dr. Goldhamer reported that the two highest gross revenues came from the treatments that received 0% of the applied water thru May 31 and then irrigated the same as the fully-watered control trees, and the treatment receiving only 25% of that of the control trees from the period May 15 through July 15 and then irrigated fully. Dr. Goldhamer went on to say that, "our early season regulated-deficit-irrigation data suggest that (seasonally) applied water can be reduced by 25% relative to fully-irrigated trees without reducing gross revenue." To keep things in perspective, I am not sure how water storage in the soil profile or average annual rainfall (which averaged 8 inches during the time of this study) was taken into account in this research.

Later, Dr. Goldhamer looked at regulated deficit irrigation in 'Lane-late navels, which, if fully-irrigated, can grow out of desirable sizes and become overly large and granulated. The following table came from a presentation that he gave in Kern County in 2008.

Seasonal Stress Period	2003-5 Mean Applied Water (inches)	Single Fruit Wt. (g)	Harvest Fruit Load (No./tree)	Total Fruit Yield (tons/ac)	Gross Revenue ($/ac)
Early	24.0	379 c	138 a	13.5	3070 a
Mid	25.0	310 b	215 c	15.5	4560 ab
Late	29.2	301 b	201 bc	15.2	6540 c
Season Long	17.0	257 a	198 bc	12.8	6220 bc
Control	37.1	392 c	155 ab	15.2	3610 a

Notice in the table that the applied water in the season-long stress was less than 50% of that of the fully-irrigated controls. In the season-long stress, fruit were smaller as were yields, but gross revenue was greater because the fruit did not become too large, and granulation was reduced. Based on this data, a grower with Lane Late navels may actually be better off with a 50% delivery reduction! I have spoken with a number of growers with late-maturing navels, who regularly only irrigate at about 75% of normal citrus ET, and report a reduction in overly-large fruit, granulated fruit, and reduced alternate bearing.

What else reduces crop water requirement?

A number of years ago I did some pruning research. One of the treatments was severe and involved spring interior pruning, topping and hedging. I ended up removing about 30% of the crop canopy. With the onset of irrigation I realized that by removing about 30% of the crop canopy, I reduced the irrigation requirement of these trees. The tensiometers in the severe pruning plots never showed any stress and the ground was always wet. By experimenting with various smaller-orificed fan-jet emitters, I discovered that the irrigation requirement of these smaller trees had been reduced in proportion to the canopy (i.e. about 30%). It should not have been a surprise. Physics and plant physiology predicts this finding pretty well. We can carry pruning only so far, but it would appear that by reducing tree canopy by about 30% we will reduce our water requirement by about 30%. Remember, however, that citrus bears fruit on one-year-old wood. If we want to produce some crop, we have to leave some one-year-old wood. Topping and some light interior pruning should be able to allow us to reduce crop water use and provide some harvestable fruit. If a large percentage of the top of a tree is removed, and large supporting scaffold branches are exposed, the exposed branches should be whitewashed or treated with another reflective material such as lime or kaolinite clay to prevent sunburn. This treatment is especially important if combined with a regulated deficit irrigation program which will decrease the ability of the tree to cool itself through transpiration.

Reduce Competition for Water

Cover crops and weeds will compete with the citrus for water. This may be the year to spend money on tillage and herbicides to keep other plant species from using the water the citrus crop needs.

<u>Possible protocol for producing some citrus fruit with a 50% or less water allocation</u>

So, how can we incorporate these research findings into a plan of action for producing a crop with only 50% of the water needed to grow a mature citrus tree in the southern San Joaquin Valley and have trees in fair condition for next season. Let's assume that the orchard is currently being irrigated very efficiently (which is another whole other topic) and that there is very little water stored in the soil and that rainfall will be negligible. Based on the research discussed above, what follows is a possible scenario for reducing crop water demand for an acre of mature citrus by about 50%, while still providing an option for some harvestable commercial citrus production.

PERIOD: Spring leaf out through bloom

1. Through topping and interior pruning, remove about 30% of the crop leaf canopy. Leave sufficient one-year-old wood to produce some fruit. After pruning, treat with copper, zinc, lime mixture to reflect sunlight and reduce sunburn and fungal/bacterial invasion. Treat with registered insecticide if wood borers become a problem.
2. Do not irrigate until mid- May. We want to harden the tree through slow development of water stress. The idea is to reduce new leaf flush and flowering and encourage fruitlet drop. Reduced fruit numbers will increase the chance of obtaining some fruit of marketable size. Some research by Dr. Pehrson, suggested that nitrogen fertilization, although reduced, should be decreased less than the irrigation water, and more frequent smaller applications to drought-stressed trees is better than a few large applications.

PERIOD: Mid-May through November 1

Irrigation scheduling

First, we don't want to do a lot of 'little' or light, frequent irrigations. Evaporation from the surface can be extreme, especially in the summer. It can approach ½ inch of water a day in an evaporation pan. We want to make each irrigation count so what we lose to evaporation is a relatively small percentage of what we apply. We want most of it to soak into the soil. This evaporation loss also suggests that we water at night and/or during days that are overcast, when a 'trace' of rain might fall. One plan for irrigating citrus with a 50% allocation, might be that we skip every other irrigation or more, but apply the same amount of water at each irrigation (assuming that we don't have any runoff) that we would have applied assuming a 'normal' 100% water allocation. If 30% of the canopy was removed, the number of seasonal irrigation events can probably be reduced further. If runoff is a problem, ensure that the soil is properly amended or tilled, to assure maximum water infiltration. By skipping, at a minimum, every other irrigation, water application efficiency should be close to 100%. The goal, which can be greatly assisted by careful soil water monitoring, will be to turn on the irrigation system at just about the point where no available water remains in the rooted area of the soil profile.

If a large summer cloud burst hits, the irrigation for that time period can be skipped. It is not advisable to provide too much additional water at one time as this could trigger summer or early flush of new growth that will increase water demand of the tree and orchard.

A second application of a reflective material, such as a kaolinite clay product, could be applied in mid-summer to reflect the high levels of in-coming summer solar radiation.

What about water wells?

If surface water is not available, existing or new wells are a welcome option on some properties. Many growers in the San Joaquin Valley have irrigation wells. It is no secret that in most areas of the Valley, groundwater extraction is exceeding recharge. As dependence on groundwater increases, a common scenario is that wells need to be deepened in many areas to maintain flow rates. Going deeper is not always an option and

in many areas no useable groundwater is available. In other areas quality is too poor for citrus, which is not tolerant of high pH, sodium, chloride, boron, or elements such as arsenic or lithium. If water quality is poor, and some good quality surface water is available from the district, mixing the two sources may be an option. Water quality should be checked at intervals through the year, to ensure that the quality remains good enough for citrus. If not, suitable amendments can be added to the water or soil, to maintain water infiltration rates and maintain a root environment sufficient for producing citrus. Wells should be tuned up prior to spring, to ensure they are moving the most water possible, as efficiently as possible.

Eventually, as we all know, snow and rain will again fall on California.

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