University of California **Cooperative Extension**

Contra Costa & Alameda Counties

CROP CURRENTS

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JULY 2015

THE WATER ISSUE

- Reducing Water Use in Trees & Vines
- Alfalfa and the Drought
- Water Quality Considerations

REDUCING WATER USE IN TREES & VINES

The state curtailed the water for the Byron Bethany Irrigation District (BBID) in late June. Fortunately, the district has been able to purchase water from other sources. Unfortunately, this replacement water is very expensive. So I've been getting a lot of questions about how to minimize the use of this very expensive water and the possible impacts of less than optimal irrigation on our permanent crops.

Remove the Cover Crop. The first thing I would suggest is to get rid of any cover crop or weeds on the orchard or vineyard floor as soon as possible. Cover crops have a number of excellent benefits but they also increase water use in the orchard or vineyard by 20-30% as long as they are actively growing. The amount they use will depend on their leaf area – a thick cover crop or tall, uncontrolled weeds will use more water than a few scattered weeds on the orchard floor.

It is common for cherries in our area to have a thick grass cover crop**.** *Killing that cover will* immediately *reduce water use in the orchard by 30%!* That represents a savings of 6 inches of water per acre from now until October in a mature orchard. If you leave the dead thatch in place you will still get the cover crop benefits of improved water penetration, weed control, and quick orchard access after irrigation. You can renovate and reseed the cover in the fall, or perhaps just drill seed directly into the dead thatch.

Instead of killing the grass outright, you could choose to "chemically mow" it with a low rate of herbicide which would stop the growth and reduce water use (although not eliminate it) until the grass starts to grow again. Chemically mowing is not something that is recommend as a regular practice as it can encourage chemically resistant weeds with continued use. But employing that technique for this one season may be warranted to save water and reseeding costs.

Fine tune your irrigation system. Make sure your irrigation system is operating correctly. Fix any leaks or breaks. Know your application rate and time your sets to avoid runoff. Maintain the system to avoid clogging and uneven distribution of water. Flushing lines and filters to reduce clogging is a good idea, but it is probably something that should have been done before the curtailment (with the cheap water).

Shorter, more frequent irrigations may be more effective under short water conditions and/or salty water conditions. This maintains the moisture in the upper soil profile and lets the trees/vines dry down the deep soil moisture. For example, a 12 hour irrigation every 10 days would be preferable to a 24 hour irrigation every 20 days, even though it applies the same amount of water. Of course your actual run time should be related to your application rate and the water need.

How much water do you need? Table 1 on page 4 shows the amount of water that MATURE trees and vines need in our area from ALL sources (rainfall, irrigation, stored

soil moisture). We call this crop evapotranspiration and it is abbreviated ETc. A tree or vine is considered mature and uses the full amount listed if it shades over 60% of the orchard floor at 1 pm in mid-summer.

A look at this table shows that July is the highest water use month, followed by August/June, followed by September/May. Use the cover crop column when you have a full cover crop (or weed crop) on the orchard/vineyard floor. When the cover crop is sprayed, disked or dies, switch to the bare soil column. Notice how much more water is used when there is a cover! If there is spotty cover or weed growth, the water use will fall somewhere in between the bare and cover columns.

The table is a useful starting place but figuring out how much of that needed water should be applied as irrigation can be tricky. In the spring, most of the water needs are met from rainfall and stored soil moisture. If we start out the season with a full winter soil profile and begin irrigating in mid April, we typically apply 85-90% of the ETc (minus any rainfall) on trees. The stored soil moisture will supply the rest of the water.

For winegrapes, we typically apply 30 to 60% of the full ETc depending on the variety, rootstock, and soil conditions. The water use listed in the table is 60% of the full amount.

Can we use less? Yes, if there is deep soil moisture available to offset the reduction in irrigation. This will be more likely in trees than vines as we usually deficit irrigate grapes to control vigor and there is not much soil moisture to draw from by mid-summer.

If you were irrigating your trees heavily in anticipation of the curtailment so your soil reservoir was completely full at the end of June and you are on a deep clay loam soil, then you should be able to apply 65-70% of the ETc for the remainder of the season with minimal impact as outlined in Table 1. The soil should supply the rest.

This assumes:

- you have a strong rootstock that has roots down to at least 5'
- your system is applying water fairly uniformly
- you are diligent in controlling weeds

However, if you do not have these ideal conditions - perhaps you have a less vigorous rootstock (like Giesla), or an old irrigation system, or are having a hard time keeping up with the weeds - then you likely have access to less soil moisture and applying 75-80% of the ETc – as outlined in Table 1 - would be a safer target level if you do not want to impact the crop this year or next.

If mature trees receive less than the full ETc from soil and irrigation water (as described above) it will reduce the crop size & weight this year and the crop set for next year. It is hard to say by exactly how much. We probably have the best data in almonds and that indicates a direct linear relationship. If the water is reduced by a certain percent, the crop will also be reduced by about that same percent.

If you don't have enough water: If you cannot irrigate sufficiently, are there other steps – besides those mentioned above – that you can take to reduce the long term impact? I've been getting a lot of questions about:

- *Whitewash:* Spraying trees with a light reflecting material like Surround can reduce sunburn on nuts but does NOT improve the water status of the tree and can in fact accelerate water loss and leaf drop on walnuts when trees are water stressed. So beware!
- *Severe pruning*: Pruning off major scaffold limbs mid-summer is more likely to cause long term problems than benefits. It can lead to sunburn on large limbs and structural problems for years to come. Research in almonds has shown that unpruned trees that survived without any irrigation recovered to full production more readily that those that had been heavily pruned once normal irrigation resumed.
- *Crop removal* may be of limited benefit. It won't reduce water use as transpiration occurs through the leaves not the fruit or nuts. In fact moisture can move from the fruit/nuts back into the tree at night to slightly improve water status. However, if you have a heavy set of fruit that is bending limbs and exposing them to sunburn, fruit thinning that keeps the limbs more upright may help to shade limbs and reduce the sun damage.

What about young trees? Figuring the water use for young trees is a little harder. The small trees don't use very much water but they also don't have extensive roots

to extract deep soil moisture. So shortly after planting, most of the water has to come from irrigation. By mid season, they are larger and are using more water but they also have a more extensive root system to extract stored soil moisture.

Allan Fulton, Irrigation and Water Resources Farm Advisor in Tehama Co, has done research on the irrigation needs of young walnuts. He has determined the amount of water that they need as a % of full mature tree ETc. This is summarized in Table 2, page 5. I have added a column that provides an ESTIMATE of the irrigation requirement for young trees for the remainder of this season. Again, it presumes that the orchard had a full soil profile at the end of June and it is on a deep clay loam soil and has a vigorous root system.

Monitoring tools. The Tables are intended to provide a general estimate to help you plan and get you in a reasonable starting place. Actual demand will likely vary based on your unique orchard/vineyard conditions.

Watch the tree/vine response and adjust as necessary. Unfortunately, by the time you see a negative plant response, irreversible damage may have already occurred.

Soil moisture sensors can help you gauge the amount of soil moisture available and monitor the rate of soil moisture depletion and your irrigation effectiveness before any damage happens.

Another excellent tool is the pressure chamber (or pressure bomb) which directly measures the plant water status and plant stress. This is one of the most useful tools during water short years as it helps you keep the plants under a reasonable amount of stress but not too much. We have good data on how to best use this tool in grapes, almonds, walnuts and prunes. I'm working on developing some data for cherries.

To find out more about the pressure chamber, download our new, free publication "Using Pressure Chamber for Irrigation Management in Walnut, Almond, and Prune" at:
http://anrcatalog.ucdavis.edu/Details.aspx?itemNo=8503

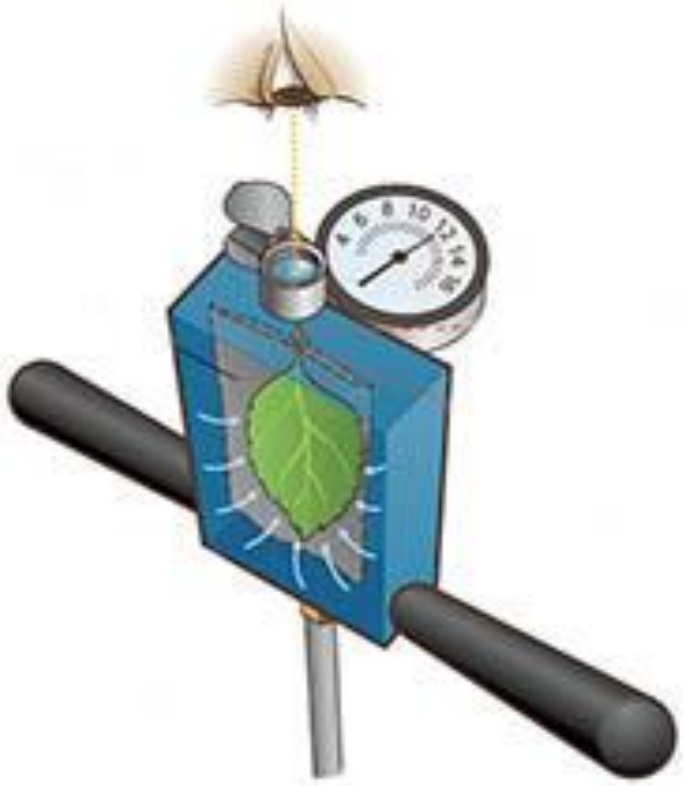

Table 1: MATURE Tree and Vine Water Use and Estimated Irrigation Requirement												
	Mature Vine Water Use (60% ETc)[1]		Estimated Vine Irrigation Requirement[2]			Mature Tree Water Use (100% ETc)[1]		Estimated Tree Irrigation Requirement[2]				
DATE	COVER CROP (inches)	BARE SOIL (inches)	50% ETc bare soil (inches)	40% ETc bare soil (inches)	30% ETc bare soil (inches)	COVER CROP (inches)	BARE SOIL (inches)	80% ETc bare soil (inches)	75% ETc bare soil (inches)	70% ETc bare soil (inches)	65% ETc (bare soil)	60% ETc (bare soil)
Mar 16-31	2.0	0.1				2.0	1.1					
Apr 1-15	2.3	0.5				2.3	1.5					
Apr 16-30	1.7	1.1				2.9	1.9					
May 1-15	2.0	0.9				3.4	2.3					
May 16-31	2.4	1.3				4.1	2.9					
June 1-15	2.6	1.6				4.3	3.2					
June 16-30	2.7	1.8				4.5	3.4					
July 1-15	2.8	2.0	1.6	1.3	1.0	4.7	3.8	3.0	2.8	2.6	2.4	2.3
July 16-31	2.9	2.1	1.8	1.4	1.1	4.8	3.9	3.1	2.9	2.7	2.5	2.3
Aug 1-15	2.6	1.9	1.5	1.2	0.9	4.3	3.4	2.7	2.5	2.4	2.2	2.0
Aug 16-31	2.4	1.8	1.5	1.2	0.9	4.1	3.2	2.6	2.4	2.3	2.1	1.9
Sept 1-15	2.0	1.4	1.2	0.9	0.7	3.3	2.7	2.1	2.0	1.9	1.7	1.6
Sept 16-30	2.7	1.8	1.5	1.2	0.9	2.7	2.2	1.7	1.6	1.5	1.4	1.3
Oct 1-15	2.1	1.2				2.1	1.6					
Oct 16-31	1.7	0.7				1.7	1.2					
Total	41.4	20.5				57.5	39.0					
Jul 1 - Oct 31 (acre-inches)	19.2	12.8	9.1	7.2	5.4	27.7	22.0	15.3	14.3	13.4	12.4	11.5
	soil contribution [3]		3.8	5.6	7.4	soil contribution [3]		6.7	7.6	8.6	9.5	10.5
						root depth		3.5'	4.0'	4.5'	5'	5.5'

[1] This is the amount of water that MATURE trees and vines need from ALL sources: rainfall, stored soil moisture, & irrigation

[2] This is an estimate of the IRRIGATION part of the full water use as a % of ETc after curtailment. It is based on the amount of soil moisture that might be available (listed in the gray box). It assumes that grapes will have depleted soil moisture and that trees may have full soil moisture for the root zone depth.

[3] This is the amount of water that the trees should be able to get from clay or clay loam soils with different rooting depths, if trees were fully watered before curtailment in late June.

To convert inches in the above table to Gallons/Tree/Week:

1. multiply inches/period by .311 2. multiply that by your tree or vine spacing (ft2) [ft. between trees x ft. between rows]

Table 2: Young Walnut Water Use and Estimated Irrigation Requirement[1]

DATE	Mature Tree Water Use = **Full ETc** (inches)	First Leaf (drip)				Second Leaf (drip)				Third Leaf (sprinkler)				Fourth Leaf (sprinkler)			
		% Full ETc	1st Leaf ETc (inches)[2]	estimated irrigation amount (30% ETc) (inches)[3]	estimated irrigation amount (gallons/ tree/wk)[4]	% Full ETc	2nd Leaf ETc (inches)[2]	estimated irrigation amount (45% ETc) (inches)[3]	estimated irrigation amount (gallons/ tree/wk)[4]	% Full ETc	3rd Leaf ETc (inches)[2]	estimated irrigation amount (65% ETc) (inches)[3]	estimated irrigation amount (gallons/ tree/wk)[4]	% Full ETc	4th Leaf ETc (inches)[2]	estimated irrigation amount (60% ETc) (inches)[3]	estimated irrigation amount (gallons/ tree/wk)[4]
Mar 16-31	1.1	10	0.1			30	0.3			65	0.7			100	1.1		
Apr 1-15	1.5	15	0.2			35	0.5			70	1.0			100	1.5		
Apr 16-30	1.9	20	0.4			40	0.8			75	1.4			100	1.9		
May 1-15	**2.3**	25	0.6			45	1.0			85	2.0			100	2.3		
May 16-31	**2.9**	30	0.9			45	1.3			90	2.6			100	2.9		
June 1-15	**3.2**	30	1.0			50	1.6			95	3.0			100	3.2		
June 16-30	**3.4**	35	1.2			50	1.7			95	3.3			100	3.4		
July 1-15	**3.8**	40	1.5	0.5	61	55	2.1	0.9	125	100	3.8	2.4	329	100	3.8	2.3	304
July 16-31	**3.9**	40	1.6	0.5	63	60	2.3	1.1	141	100	3.9	2.5	340	100	3.9	2.3	314
Aug 1-15	**3.4**	45	1.5	0.5	62	60	2.0	0.9	123	100	3.4	2.2	296	100	3.4	2.0	274
Aug 16-31	**3.2**	45	1.5	0.4	59	60	1.9	0.9	118	100	3.2	2.1	283	100	3.2	1.9	261
Sept 1-15	**2.7**	40	1.1	0.3	43	55	1.5	0.7	88	100	2.7	1.7	232	100	2.7	1.6	214
Sept 16-30	2.2	40	0.9	0.3	35	55	1.2	0.5	72	100	2.2	1.4	188	100	2.2	1.3	174
Oct 1-15	1.6	35	0.6	0.2	23	50	0.8	0.4	49	100	1.6	1.1	143	100	1.6	1.0	132
Oct 16-31	1.2	30	0.4			45	0.5			100	1.2			100	1.2		
Total	38.3	----	13.2			----	19.7			----	36.0			----	38.3		
Jul 1 - Oct 31 (acre-inches)[5]			8.9	2.6			12.4	5.3			22.0	13.5			22.0	12.4	
soil contribution[6]				6.3				7.1				8.5				9.5	
root depth[7]				3.5'				4'				4.5'				5'	

NOTES:

[1] Based on research by Alan Fulton in Tehama Co. and adapted to Brentwood using historical weather data. It assumes the orchard is drip irrigated in years 1 and 2, converted to full coverage sprinklers in year 3, no cover crop, weeds controlled.

[2] This is the amount of water that this age tree needs from ALL sources: rainfall, stored soil moisture, & irrigation

[3] This is an estimate of the IRRIGATION part of the full water use (ETc) - (subtract any rainfall during the period)

[4] For an orchard spaced 18'x 24' = 432 ft^2 = 101 trees/A

To convert from inches to gal/tree for a different orchard spacing:

$$\text{gal/tree/week} = \frac{\text{inches/interval} \times .622 \times \text{tree spacing } (ft^2)}{2 \text{ weeks/interval}}$$

[5] The total amount of water needed for the rest of the season after the curtailment in late June - from all sources (box 1) and from irrigation (box 2).

[6] This is the amount that the trees should be able to get from Brentwood clay loam soils if trees were well watered until the cutoff in late June.

[7] The soil contribution estimate is based on the expected rooting depth on a Brentwood clay loam soil which can hold 2" of water per foot of soil.

ALFALFA AND THE DROUGHT

Excerpts from an article by Dan Putnam,
UC Cooperative Extension Alfalafa & Forage Specialist

The 2013-2015 California drought has brought much public attention to the amount of water used in agriculture, and particularly which crops use the most water. Although almonds have taken the hit lately, alfalfa is often one of the favorite whipping boys of agricultural critics due to its high water use on a state-wide basis. But is alfalfa's water profile really so miserable?

Alfalfa does not really use more water than other crops. At full canopy (when the leaves cover the soil surface), alfalfa's water use is not much different than other crops - think spinach, lettuce, tomato, wheat, almonds or corn. Alfalfa's water use profile in California is primarily due to its high acreage and nearly year-round growth pattern in many regions. If spinach were continually grown on 850,000 to 1 million acres all year long, the water use would be about the same as alfalfa, perhaps more.

Water Use efficiency: Further, it's not so much how much water is used, but how much crop is produced per unit of water that is important – also known as Water Use Efficiency. In that category, alfalfa shines.

It also has a range of biological characteristics that make it very useful when a farm or an irrigated region is faced with drought conditions and resulting water limitations. These are:

Deep-Rootedness: Alfalfa roots are commonly 3-5 feet deep and can extend to 8-15 feet in some soils. Therefore this crop can utilize moisture residing deep in the profile when surface waters become scarce and applied water is never wasted. These deep roots enable the crop to survive periodic droughts.

Perenniality: Unlike summer-grown annual crops, alfalfa grows for 4-8 years. It grows quickly with warm conditions in the spring, and can utilize residual winter rainfall before irrigation is necessary. In many areas, the first cutting of alfalfa of the year requires zero irrigation– supported only by rain and residual soil moisture.

Very High Yields: Alfalfa is a very high yielding crop, and can grow 365 days a year in warm regions. Its biomass yields are very high and high-yields create higher Water Use Efficiencies.

High Harvest Index: Alfalfa's Water Use Efficiency is not only due to high yields, but because nearly 100% of the above-ground plant material is harvested. So you get more crop per drop than in most seed-producing and fruiting crops, where only a portion of the plant is harvested.

Salt Tolerance/Ability to Utilize Degraded Water: Alfalfa has a high degree of salt tolerance and can use degraded recycled water (municipal waste water, drain water, other waste water) instead of fresh water.

Contribution to Wildlife Habitat: In a drought, all of nature suffers. Alfalfa has been shown to be a significant wildlife habitat due to its lush foliage and insect diversity. Biologists have determined that 28% of California's wildlife use alfalfa for nesting, feeding, or cover. Even partial-season irrigation during drought can assist wildlife to survive a drought period by using alfalfa as habitat. Don't believe it? Visit an alfalfa field and observe the egrets, curlews, hawks, eagles, snakes, deer, antelope, elk, insects, and many birds and mammals who are at home there.

Ability to Survive a Drought: Alfalfa evolved in regions of the world with long hot dry summers and wet winters – exactly like California. Although yields are highest with full irrigation, alfalfa can survive periodic droughts due to deep roots as well as ability to go 'summer dormant' under dry conditions. In 2014, Central Valley growers that were forced to stop watering their alfalfa fields generally found the crop recovered after rainfall or when irrigation resumed later in the year.

Ability to Deficit Irrigate & Obtain Partial Yields: Typically 50-60% of full yields are obtained by mid to late June. If only partial water is available, irrigation water can be applied early (supplemented by winter rains and residual moisture), and the crop dried down during late summer periods.

SUMMARY: It is this combination of deep roots, high water use efficiency, salinity tolerance, the ability to utilize rainfall early in the year, survive droughts, utilize degraded water, and give partial yields with as much as half of the irrigation water that makes alfalfa particularly valuable in a drought. It is additionally very valuable to wildlife, which also suffers during a drought. Oh, and by the way, it is also very valuable to the millions of consumers who depend upon the milk, cheese, yogurt, and ice cream, produced from alfalfa.

See the full article at: http://bit.ly/1Hpnsi3

WATER QUALITY CONSIDERATIONS

We expect the water to be a little saltier this year as there has been a lot less rainfall and snowmelt contributing to the river water. If the water is too salty the plants expend a lot of energy excluding the salt when they take up water and this occurs at the expense of growth and yield.

The salt content of our river water normally changes over the season with higher salts in the fall (and winter if we don't have much rain) and lower salts in the spring and summer as snow melt and water releases are added to the river. That is not the case this year as we had very little snow and much reduced releases from our storage reservoirs. The salt levels have steadily increased from the 600 dS/cm range in May to 800 dS/cm range in June where they have generally remained.

How much salt is too much? Well, it depends on the crop and the AVERAGE salinity of the irrigation water THROUGHOUT the season. Generally, if water is below 700 uS/cm it is suitable for even the most sensitive crops like beans and strawberries and won't have any negative effect on growth and yield – the plants should be able to achieve 100% of their potential yield (see the Yield Potential Table). Sweet corn, peppers, and most of our tree fruit can tolerate salinity up to 1000 or 1100 <u>all season long</u> without any effect on yield. It is unusual for our salinity to get as high as 1000 during the irrigation season, but it might this year. If it goes a little above the maximum threshold (the 100% yield column) for your crop as the season progresses, it's OK if the salinity has been lower than that for much of the season. Many of our sensitive trees can tolerate salinity as high as 1400-1500 <u>all season long</u> with only a 10% reduction in yield.

Don't skip an irrigation if the water is saltier than the threshold – instead, <u>irrigate a little more frequently but for a shorter duration</u>! This may sound counterintuitive. You are adding a little more salt but you are also adding water on a more regular basis. This helps to keep the salts that ARE in the rootzone more dilute and it takes less energy for the plants to extract the water. So the best approach is to keep the rootzone a little moister with shorter, more frequent irrigations if the water is a little salty.

To convert the table values from Electrical Conductivity (dS/cm) to Total Dissolved Solids (TDS) in ppm, multiply by 0.64.

CROPS		YIELD POTENTIAL due to irrigation water salinity (uS/cm)				
		100%	90%	75%	50%	0%
Field Crops						
MS	Alfalfa	1300	2200	3600	5900	10000
MS	Corn	1100	1700	2500	3900	6700
Vegetable Crops						
T	Asparagus	2700				
MT	Zucchini	3100	3800	4900	6700	10000
MT	Artichoke					
MS	Scallop Sqsh.	2100	2600	3200	4200	6300
MS	Garlic	2000				
MS	Tomato	1700	2300	3400	5000	8400
MS	Cucumber	1700	2200	2900	4200	6800
MS	Corn	1100	1700	2500	3900	6700
MS	Pepper	1000	1500	2200	3400	5800
MS	Kale					
MS	Melon					
MS	Pumpkin					
S	Onion	800	1200	1800	2900	5000
S	Bean	700	1000	1500	2400	4200
Fruit and Nut Crops						
MT	Fig					
MT	Olive	2800				
MT	Pomegranate					
MS	Grape	1000	1700	2700	4500	7900
S	Citrus	1100	1600	2200	3200	5300
S	Peach	1100	1500	1900	2700	4300
S	Apricot	1100	1300	1800	2500	3800
S	Almond	1000	1400	1900	2800	4500
S	Plum	1000	1400	1900	2900	4700
S	Apple					
S	Cherry					
S	Loquat					
S	Pear					
S	Persimmon					
S	Walnut					
S	Blackberry	1000	1300	1800	2500	4000
S	Strawberry	700	900	1200	1700	2700

<u>Codes:</u>
T = Tolerant
MT = Moderately Tolerant
MS = Moderately Sensitive
S = Sensitive

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Hope you find something of interest in this issue.

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TIME SENSITIVE MATERIAL

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